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COVER—The *Millennium Falcon* soars over Tatooine in *Star Wars*.

# AFTER THE REBELLION

Despite a substantial effects budget and the stewardship of a major motion picture studio, the original *Star Wars* ‘miniature and optical effects unit’ — as it was called in the film’s final credits — worked without a time clock and, some would say, without a net. The crew of more than fifty toiled in an industrial warehouse in Van Nuys, California — a facility with third-hand furniture throughout and a screening room that earned the designation only because it had a screen, a projector and an old mattress with springs poking out.

In some respects, the crew was as lacking in polish as the surroundings. With an average age in the late twenties, its members were young, largely inexperienced in feature filmmaking, and openly contemptuous of Hollywood ways. The group’s youth and the company’s ragtag trappings did little to allay the concerns of the 20th Century Fox executives overseeing the picture, many of whom feared the space opera would crash at the boxoffice. The lack of faith from the higher powers created an embattled production atmosphere that made many a crew member identify with the struggles of the movie’s Rebel Alliance. Neither the rebels nor the suits dreamed that the work would make movie history, usher in the modern effects era, and launch the legend of Industrial Light & Magic.

On its twentieth anniversary, ILM stands as the film industry’s preeminent effects house, annually garnering a significant majority of the approximate \$150 million in ‘A’-picture effects billing. Company credits include work on six of the ten all-time boxoffice hits, fourteen best visual effects Academy Awards and ten technical achievement awards for breakthroughs ranging from motion control to the virtual visions of the digital age. In addition, ILM has successfully diversified into theme park simulator ride films, commercials and music videos.

But this success has been accompanied by an underlying industry buzz that ILM has become too big, and that, in the process, has lost some of its creative spirit. “We’ve been characterized as being monolithic,” stated company president Jim Morris. “The truth is that ILM has always been about doing individual projects. The team working on *Mission: Impossible* has the same esprit de corps as the group that worked on the original *Star Wars*. Ultimately, ILM is a culture of visual effects artists — and you can’t get artists to work under a corporate structure. We have to maintain an atmosphere conducive to the artist.”

ILM’s present-day organizational structure, with its emphasis on specialization, is far different from its free-form early days. Today, there is a strict line of command that begins with the client and flows from the effects producers and supervisors out into the particular effects departments and personnel. Given the high stakes and deadline pressures of modern filmmaking — especially for the potential blockbuster projects that ILM excels in — specialization is a necessity. “We have a



pyramidal structure,” explained twenty-year veteran Dennis Muren, “because if everybody has equal say, you get chaos. There’s no way to get a director’s vision on screen unless the work is filtered and channeled. Some people believe that’s too restrictive and specialized; but you can’t run any organization as a free-form thing. If the company is doing five movies, it is essentially like five separate companies. Each film is a different challenge. Because the quality of the work has to be so high, you want your best people working in any given area. By working in a structure, people can grow in their art.”

Another difference between the ILM of today and its *Star Wars* counterpart is the digital innovations — many pioneered by ILM — that have recently recast both the company and the entire effects industry. With ILM becoming a high-tech colossus, the efficient organization of digital effects tools has become an imperative. Certainly, ILM’s evolution from a stage-oriented, traditional effects firm into a largely digital effects house is behind some of the corporate aspersions. But while some lament the passing of photochemical opticals and the reduction in stage craft, the digital tools have also allowed artists to go beyond the limits of the physical world. “Because of the new digital tools, the work is, in many respects, a lot easier than in the *Star Wars* days,” Muren observed. “It was awful back in dailies on *Star Wars* — seeing that the lighting might have been a little off in a shot, and knowing it was going to be in the movie anyway. Now we can do shots perfectly.”

“In the opticals era, it was actually more of an assembly process,” elaborated Morris. “Now one person can build a model in the computer and comp it. With digital work, you have people at work stations self-managing and supervising themselves. Individuals have more ownership over the work, as opposed to the group efforts of the past.”

There are a number of company rituals to help ensure that all those self-managing artists not become islands unto themselves. A notable event is ‘monthlies,’ in which all employees assemble for a screening of finals work created throughout the company. To encourage creative growth on an individual basis, the company also provides for visiting lecturers, life-drawing classes, and has an internal grant program available to help fund employees’ independent film work. In response to changing employee needs, ILM houses both fitness and day care centers.

And then there are the parties. To lighten the pressures, the company hosts bashes that range from informal end-of-the-week gatherings to George Lucas’ annual Fourth of July picnic at Skywalker Ranch. Other ILM customs are a little quirkier, such as the bagels and pastries provided each Tuesday, or the donuts available in the CG department on any Friday that falls on a prime number.

Lucas’ decision to relocate to the San Francisco Bay area, rather than remain in Southern California, has also influenced the company’s corporate environment. The surrounding rural countryside has provided a range of photogenic landscapes for the filming of background plates, while ample industrial warehouse space has facilitated large-scale stage work. Production possibilities aside, the aesthetic diversity of the area, from the cosmopolitan streets of San Francisco to the redwood groves across the Golden Gate, has proven to be advantageous to the company. “The quality of life here is so good,” observed Muren. “You can go sailing in the bay; and there are woods all over the place where you can go hiking or mountainbiking. In fact, the computer guys do the most biking, hiking and playing sports, defying the computer-nerd stereotype. They spend so much time sitting in front of monitors, they know they need to get out and exercise.”



“Being in Marin County, you have environmental circumstances that people are very receptive to,” Morris added. “It’s a good scene for artists. People in L.A. come and go; but we have relatively little turnover. Like any group that works together for a while, strengths build. A history and a culture have grown up over the years.”

Iconic trophies representing that storied history are on display in the company’s reception areas, hallways and offices. Once beyond the nondescript front of ILM’s facility — whose scattered buildings still bear the faded logos of long-gone tenants — a visitor might see a case holding the stop-motion puppet of Luke Skywalker leaning on the handlebars of a speeder-bike from *Return of the Jedi* or the sculpted models that inspired the CG metamorphic stages of the liquid metal terminator in *T2*. Matte paintings of Never Neverland created for *Hook* hang on the walls, as do posters from nearly every movie ILM has touched. The momentos serve as a reminder that the company’s current work will always be measured against the successes and breakthroughs of its past.

Perhaps it is the scale of modern moviemaking, with its billion-dollar global grosses and calculated merchandising campaigns, that makes some pine for the funky, freewheeling *Star Wars* days of old. That initial ILM adventure was a true creative frontier, with a hardy team of pioneers innocently breaking all the rules, and making up some new ones, as they conjured up a universe.

“*Star Wars* was an exciting first time,” Jim Morris remarked. “But it is not unlike what happened on other individual projects, such as *The Abyss*, where we all had to hunker down and create breakthrough CG effects. Sometimes when we talk about our work on those shows, we sound like a bunch of old fogies talking about the good old days. There’s a certain golden light that falls on those memories. And five years from now, we’ll be remembering the shows we’re working on today. The enthusiasm and spirit of the company is the same now as it was during *Star Wars* — it’s just that we’re not a garage operation anymore.”

# 20 Years of Industrial Light & Magic

A PROJECT-BY-PROJECT OVERVIEW

BY JODY DUNCAN

“In the beginning, working with ILM and watching them attempting to fulfill my wish list of ideas was a little like standing on the end of a three-meter diving board, staring down into poured concrete with just a couple of puddles here and there. And yet, together, we managed to leap without looking. Leaping without looking has made George Lucas’ company the greatest show since P.T. Barnum; and all of us in the movie business who are fortunate enough to hear ILM say, ‘Yes, we’ll do your movie with you,’ can bear witness to that fact.

With its digital breakthroughs — starting with the first digital effect ever photographed for a commercial movie, *Young Sherlock Holmes*, to the ghosts in *Casper*— ILM has entered the most exciting era in all cinema history. I know they will continue to dream and scheme with imagination and a responsibility to not allow digital technology to create a synthetic cinema, but instead, to continue to bring to life such things that only the imagination can wonder about.”

— Steven Spielberg

## 1977 *Star Wars*

Written and directed by George Lucas, *Star Wars* revolutionized the visual effects field, while raising audience awareness and appreciation of the art form. Headed by John Dykstra, a team of young and enthusiastic modelmakers, effects cameramen, animators and optical wizards convened at an empty Van Nuys warehouse in 1975 with the objective of creating some 360 effects shots for the epic space opera. Within a few short months, the building was converted into a fully functional effects facility, christened Industrial Light & Magic.

The challenge set forth by Lucas was to create spectacular footage of spaceships in battle, complete with free-form camera moves that would forever stigmatize the locked-off camera that had hitherto been the norm in model photography. To meet that challenge, fanciful spaceship miniatures were built and new effects tools were developed – most notably a motion control camera system, the Dykstraflex, that facilitated the compositing of numerous elements through its capacity to reliably repeat multi-axis camera moves. A single model could be rephotographed and layered into a final composite to create a fleet of spaceships. To limit the image degradation that occurs when original negative is duped during compositing, models were filmed in Vistavision, a horizontal eight-perf format that provided an enlarged image area, but necessitated the design of newly configured, more flexible optical printers.

Technological advances were also made in bluescreen matting procedures. Fluorescent tubes used to backlight the screen were converted from AC to DC to eliminate flicker, and a blue pylon was devised as a means of invisibly supporting the models. Garbage mattes to eliminate unwanted images in the bluescreen photography were executed by the rotoscope department, which was also responsible for enhancing explosion and laser effects through original animated artwork.

While battling TIE fighters and X-wings dominated the film, some of ILM's most interesting work was featured in brief moments of magic, such as a holographic chess game achieved through stop-motion animation. Fledgling computer graphics work was also featured in a scene revealing the Death Star on a monitor display.

#### 1980 *The Empire Strikes Back*

While *Star Wars* had used motion control to create space sequences, *The Empire Strikes Back* – directed by Irvin Kershner – was more planet-bound, featuring a huge battle between Rebel and Imperial forces on the arctic planet Hoth. As the sequel geared up, ILM was reconstituted at a new facility in Marin County. Amidst the trials of establishing a new facility, Richard Edlund – who served as co-supervisor with Brian Johnson – concentrated his early efforts on developing a high-speed Vistavision camera and a four-projector-head optical printer for compositing. The new printer, coupled with an increased sophistication in bluescreen techniques, resulted in mattes that were far superior to those in *Star Wars*.



For *The Empire Strikes Back*, Richard Edlund prepares to shoot a walker being rigged by Ed Hirsch, Jon Berg and Steve Gawley.

At Dennis Muren's urging, ILM also created a stop-motion department to realize the tauntaun and snow walkers featured in the battle sequence. A marriage of motion control and standard stop-motion techniques elevated some of the tauntaun shots and laid the groundwork for go-motion. The Empireflex – designed by Edlund – was the primary camera used for the stop-motion sequences, realized primarily by shooting models on miniature sets, or in conjunction with painted backdrops and foreground glass paintings. Matte paintings included a cloud city and a bog on Yoda's planet that were rendered on glass, then matted via a front-projection system that facilitated the incorporation of live-action into designated areas.

More than fifty miniatures were constructed, including a smaller, lighter-weight – and therefore, more manageable – Millennium Falcon. The new model was put through its paces for a sequence in which the ship maneuvers its way through an asteroid belt. Two years were required to fully equip the new ILM facility and complete the film's 400 effects shots.

#### 1981 *Raiders of the Lost Ark*

With *Raiders of the Lost Ark* – first in a series of high adventures involving archaeologist *Indiana Jones* – Lucas and director Steven Spielberg combined forces to create a 1930s-style Saturday matinee-type movie, flavored with state-of-the-art effects. In a leap of faith, Spielberg surrendered almost the entire ending of the film – in which the unsealing of the long lost Ark of the Covenant results in a cataclysmic supernatural event – to ILM's postproduction ministrations, under the supervision of Richard Edlund.

Matte paintings and opticals enhanced live-action footage that had been shot on stage by the main unit. To provide backgrounds for the lengthy effects sequence, a forty-foot-long replica of the altar set was constructed in a warehouse across the street from ILM. Combined with those backgrounds were ghostly images created both through cel animation and water tank photography of wire-manipulated silk swatches. The apparitions were layered into shots in as many as fifty in-camera passes to maintain image quality. The water tank, injected with paint, was also used to generate ominous clouds for wide shots of the supernatural holocaust.



*Death comes to the Nazi defilers in Raiders of the Lost Ark.*

To produce a firestorm that engulfs the tableau, pyrotechnic effects were executed on an upside-down miniature set. The animation department added to the fiery display with body-piercing lightning bolts, while gruesome makeup effects created the illusion of melting Nazis. Concluding the film was an expansive matte painting showing the crated Ark being stored in a massive warehouse.

### *Dragonslayer*

ILM skillfully applied both old and new effects technologies to director Matthew Robbins' *Dragonslayer*. While full-size props served to represent the dragon in some shots, the majority of its scenes were realized at ILM by Dennis Muren – in his first stint as effects supervisor – Phil Tippett and Ken Ralston. Motion control technology was adapted to stop-motion-style puppet animation, resulting in a process – dubbed 'go-motion' – that created smooth character articulation and realistic motion blur. A variety of dragon rod puppets were built and mounted on a programmable model mover, then photographed either in front of a bluescreen or on miniature sets.

While go-motion produced stunning shots of the full-grown dragon walking and flying, three life-size hand puppets operated from beneath an elevated live-action set were employed to represent dragon babies. Also employed was a half-scale dragon head, photographed in miniature cave settings. Since effects shots were to be intercut back-to-back with live-action footage, Muren took great pains to ensure lighting and atmospheric smoke levels were precisely duplicated in the miniature setups.

### *1982 Poltergeist*

ILM was again commissioned by producer Steven Spielberg to create visual effects for *Poltergeist*, an exploration of paranormal phenomena, directed by Tobe Hooper. Nilo Rodis conceived the effects, while Richard Edlund supervised. Severe weather conditions – such as thunderstorms and a tornado that rips through a suburban neighborhood – were achieved using cloud tank footage composited with matte paintings.

An animation department of twenty was set up to generate the poltergeists themselves. Animated smoke shapes were photographed in multiple passes to create generic spirits, while replacement

animation suggested a spectral hand emanating from the family television screen. Other spirit forms were more clearly defined, such as a woman who appears on a staircase – achieved through highspeed photography of a fabric-draped actress flown against black. Shots of actors on a black set with lights attached to their chests were tweaked in the optical department to create barely discernible apparitions. In some instances, the spirits were not seen – but their presence was made known. For a scene in which objects fly around a child's bedroom, props mounted on cables, pylons or spinning shafts were shot bluescreen and composited into a background plate.

A major sequence had a desperate mother braving a sinister closet to rescue her small daughter from the spirit realm. For a shot of a huge beast head that appears, a miniature closet door and an oversize, track-mounted skull were photographed. A full-size door was then aligned in-camera to blend with the foreground miniature. Subsequent shots revealed the beast's gaping esophagus – a half-scale miniature suspended from a pipe and manipulated by vacuum pumps to create an undulating movement. In a hallway scene, the beast was represented by a lightweight marionette photographed in the water tank.



*A firestorm sweeps across a barren planet as the Genesis effect – an early computer graphics sequence – is demonstrated in Star Trek II.*



Later, mother and child burst through the living room ceiling, the portal between the spirit and physical worlds. The live-action ceiling was duplicated on an ILM stage, covered by a thin membrane. Sculpted foam dummies were pulled through the membrane by pulley-controlled ropes. Animation and laser enhancements supplemented the practical effect. Lasers were also employed to create shock waves emanating from the home as it implodes near film's end – an effect achieved via a miniature house rigged to collapse with wires and cables. Shot high-speed, the imploding model was composited with matte paintings and cel animation.

#### *Star Trek II: The Wrath of Khan*

Director Nicholas Meyer's *Star Trek II* required a demonstration of the Genesis effect – a process that produces life from inorganic matter. Effects supervisor Jim Veilleux worked with the Lucasfilm computer graphics research division to realize the demonstration, which featured CG images of a projectile striking a barren planet's surface, a resulting firestorm and, finally, the rapid evolution of mountains, seas and greenery – all against an accurate CG starfield. A team of eight worked on the sequence for five months, developing texture mapping, painting and compositing programs. The demonstration's final image of an earth-like planet was a digital matte painting – ILM's first. Traditional matte paintings were also featured throughout the film, simulating views of planets, moons and the Eden Cave.

Co-effects supervisor Ken Ralston oversaw additional effects, including bluescreen motion control photography of the *Enterprise* – a model originally built for the first film – and other spacecraft. Ralston was also charged with the sequence in which *Enterprise* crew members are infested with an eel-like alien parasite, represented by rod-manipulated foam puppets. For the film's finale – featuring ships within a massive nebula of billowing gas – an inversion layer was formed in a water tank, then injected with latex rubber and illuminated with gelled lights. The tank footage was optically composited with model photography.

#### *E.T.: The Extra-Terrestrial*

While the most obvious effect in Steven Spielberg's *E.T.* – *E.T.* himself – was orchestrated by Carlo Rambaldi, ILM and effects supervisor Dennis Muren contributed approximately fifty key shots to the film.

Images of *E.T.* and his human friends on flying bicycles were realized with go-motion miniatures shot as bluescreen elements and inserted optically into live-action plates. Inserts of the young



*An extraterrestrial and his earth friends bicycle past the setting sun in E.T.*

actors on real bikes – mounted to crane arms and shot bluescreen – helped to sell the illusion. The film's signature image – E.T. and the boys on bikes, flying across a giant moon – employed an actual moonrise shot with a long telephoto lens.

The model shop built miniature forests, a forced-perspective suburban neighborhood, and E.T.'s mothership. Forest reflections on the glossy mothership were achieved by surrounding it with a painted dome.

E.T. saw ILM's first use of its new VistaCruiser camera – a smaller version of the Dykstraflex, equipped with a longer boom arm and both four-perf and eight-perf capabilities. For the first time, ILM shot its effects in four-perf, rather than Vista-vision, since Spielberg had elected not to shoot his live-action in widescreen. A new, highly flexible boom rig – the Fitzmatic – also debuted as a means of shooting moving bluescreen elements in real time, without the need for animation. The rig was used to photograph suspended objects for a scene in which E.T. demonstrates his planet's location in the galaxy.

### *The Dark Crystal*

With the company heavily involved in overlapping production schedules for *E.T.*, *Poltergeist* and *Star Trek II*, ILM's matte department still managed to deliver seven shots within a four-month period for *The Dark Crystal* – a Muppet fable from Jim Henson and Frank Oz. Paintings included fantastical landscapes, some rendered on glass to allow for the rear-projection of live-action. The final shot in the film was a composite that included a painting of a crystalline castle surrounded by greenery, three overhead suns and a shimmering lake captured practically at a river site.

### 1983 *Return of the Jedi*

Effects for *Return of the Jedi* – directed by Richard Marquand – were divided among supervisors Richard Edlund, Dennis Muren and Ken Ralston. With more than 900 shots to produce, the company's physical plant expanded to include a new building and stage. Additional camera rigs were also built, including the Technirama, a highspeed, servo-driven track system capable of very fast moves. Jedi also saw the revamping of ILM's motion control system, as well as the development of a field operable unit.

Edlund was charged with scenes involving Jabba the Hutt's giant barge on the desert planet of Tatooine, as well as the final Rebel attack on the new Death Star. Jabba and his alien minions were produced by ILM's monster shop —headed by Phil Tippett – which turned out creature suits for a year. For the desert battle, Edlund photographed actors bluescreen on a full-size skiff mounted on pylons, using camera movement to simulate the craft's maneuverings. Long shots employed stop-motion figures aboard miniature skiffs. Also featured in the sequence was the Rancor pit creature – a hand-and rod-actuated puppet – and the explosion of Jabba's barge, achieved in miniature.

To provide background plates for scenes of Rebel ships infiltrating the Death Star, elaborate tunnel models were built. The new, more flexible motion control system, along with increased confidence in shooting motion control, resulted in random, live-action type camera moves in the miniature photography.

Muren oversaw the high-speed flying bike chase through the Endor forest, which was first choreographed in videomatics produced via the Ultimatte video system. Actual forest backgrounds were filmed by mounting a Vistavision camera on a Steadicam unit and shooting one frame per second. Composited into those plates were bluescreen shots of miniature speeder-bikes and riders. Bikes and the camera moves were motion controlled, with figures on the bikes manually articulated by rods that were later rotoscoped out. For closeups – shot bluescreen, with actors on full-scale bikes – Muren devised a sequencing system that threw lighting on the actors in a random pattern, creating the illusion of the bikes moving through ever-changing environments. Also set in the Endor forest is a rebel clash with Imperial scout walkers that were rendered in miniature, shot bluescreen and animated via go-motion. Walker elements were then matted into live-action plates.

A massive space battle was supervised by Ralston, who had logged more hours on such photography than anyone at ILM. While a half-dozen models had sufficed for *Star Wars*, the scale of *Jedi*'s battle required hundreds of ships and a record number of elements. Six motion control crews were employed around the clock.

From the matte department came forest paintings and a wide shot of Jabba's palace. Paintings were combined with live-action via the Automatte – a new multiplane matte camera with a built-in motion control system. Compatible with both eight- and four-perf formats, the new system also featured a superior anamorphic lens. In a vast improvement over standard locked-off matte shots, the Automatte facilitated sweeping camera moves on the background plates. *Jedi* also saw ILM's first incorporation of foreground miniatures with matte paintings in an expansive shot of the Death Star docking bay. CG effects provided tactical displays, including a 3-D vector representation of the Death Star in orbit.

### *Twice Upon a Time*

*Twice Upon a Time* was Lucasfilm's first and only venture into feature animation. Directed by John Kory and Charles Swenson, the film featured animated cut-out figures, rather than traditional cel animation. ILM was called in to perform optical compositing duties.



*Ken Ralston animates stop-motion figures aboard a levitating skiff for *Return of the Jedi*.*

### 1984 *Indiana Jones and the Temple of Doom*

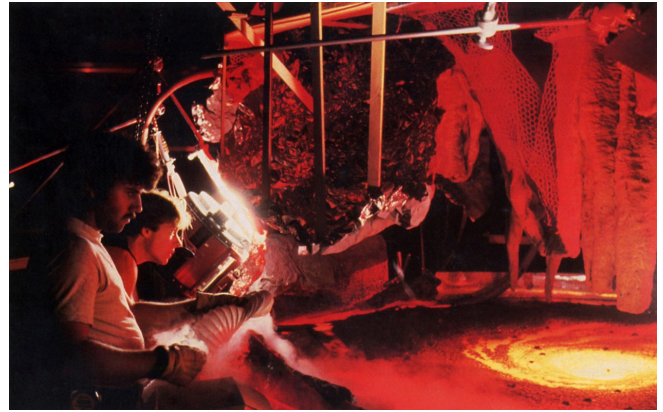
The action centerpiece of *Indiana Jones and the Temple of Doom* – second in the series by Steven Spielberg – was a mine car chase that took four months to realize and accounted for a third of the film's 140 effects shots. In order to achieve shots covering long distances, supervisor Dennis Muren opted to create the cars and mine tunnels in as small a scale as possible, precluding the use of standard motion control cameras, which were too large to fit. Muren commissioned Micheal McAlister and Pat Sweeney to modify a Nikon still camera for the photography.

The result was a palm-size Vistavision format camera. Tunnel sets were built of industrial-strength aluminum foil and outfitted with wide-gauge model railroad tracks, figures in the mine cars were stop-motion animated, or radio controlled when limited space prevented access. The mine cars themselves were motion controlled to introduce realistic motion blur into each frame. For a scene in which Indy is chased by a wall of water within the tunnels, a bluescreen element of Harrison Ford was composited with a background plate of water rushing through a miniature.

Indy and his friends emerge from the tunnel to find themselves on the edge of a sheer precipice. Wide shots of the cliff face were achieved with matte paintings, into which live-action elements of the actors were rear-projected. The finale also employed a rock face miniature and split-screen composites to create the illusion of an alligator-infested river below. Shots of characters plummeting into the river were achieved with stop-motion puppets, photographed against bluescreen and composited into live-action plates.

Models were constructed for a Trimotor cargo plane and the Great Wall of China, designed as a forced perspective miniature. While motion control photography of the plane passing over the wall was farmed out to Dream Quest Images, ILM built the models and was also responsible for exterior, wire-rigged photography of the plane skimming a snowy mountaintop. For a subsequent crash, a larger mountain miniature was constructed and filmed in conjunction with the plane model.

Realistic lava effects in a subterranean vault were generated by photographing a mixture of red-tinted glycerin and water – illuminated from below with gelled lights – and compositing the imagery into plates shot on a live-action set. A vortex of lava appears in a scene in which a sacrificial victim is lowered into a pit. While up-angles were done practically on the set, down-angles were realized at ILM with a cave model and a plexiglass vortex into which five tons of glycerin were pumped. A radio-controlled half-scale puppet was shot in a cage against bluescreen, then composited over the lava vortex.



Bob Finley III directs dry ice mist into a lava vortex, simulated with backlit tinted glycerine, for *Indiana Jones and the Temple of Doom*.

### *Star Trek III: The Search for Spock*

In *Star Trek III* – ILM's second foray into the continuing adventures of the starship Enterprise – effects supervisor Ken Ralston and team were involved in design and storyline issues with director



Leonard Nimoy at the earliest stages of production. The film's effects were characterized by exceptionally long shots, some as long as 500 frames. A number of new miniatures were commissioned, including an orbiting space station featured as the Enterprise returns to drydock. Also required were a new Federation starship, the *Excelsior*, and the Klingon *Bird of Prey* – decloaked in an optical effect achieved by throwing color separations out of sync.

Creatures for the show included a Klingon mascot – a reptile-dog hand puppet with cable-actuated facial movement – and worm-like creatures operated through pneumatic controls and off-camera manipulation of rods and wires.

In an attempt to revamp the old transporter effect, the animation team came up with a technique in which a high-intensity light was mounted on an animation stand and directed toward a rotomatte of the transportee. Filtration caused the light to striate in all directions as it traveled over the person's image in a computer programmed move. The animation department also improved upon the warp drive effect featured in previous Trek outings. Computer animation makes a brief appearance in a holographic game in which two biplanes engage in a dogfight.

Establishing views of the Genesis planet were realized with a large cyclorama. Destruction of the planet was achieved on a miniature set rigged to collapse and spew fire. Miniature pyro was also responsible for the destruction of the Enterprise, shot high-speed. The ship's fiery descent to the planet was represented by a track-mounted torch enhanced with an animated smoke trail. The film ends on the planet Vulcan, created through a combination of matte paintings and miniatures.

### *The Neverending Story*

Although ILM is not credited on the Wolfgang Petersen fantasy. *The Neverending Story*, the company did provide an optical and matte painting unit that composited bluescreen elements and provided painted backgrounds. Effects supervisor Brian Johnson – who had teamed with ILM on *The Empire Strikes Back* and *Dragonslayer* – shot all of the background and bluescreen plates for the film.

### *The Ewok Adventure*

Lucas' first primetime television offering, *The Ewok Adventure* – produced by former ILM general manager Tom Smith and directed by John Korty – featured the furry critters introduced in *Return of the Jedi*, most played by little people in suits. Under supervisor Michael Pangrazio, ILM supplied latent image matte paintings that provided spectacular views of castles and an alien landscape. Bluescreen photography was mandated for process shots of ewok and human characters interacting with a giant beast, the Gorax – designed, built and performed by Jon Berg. Stop-motion creatures, animated by Berg and Phil Tippett, also populated the film. *The Ewok Adventure* – known also as *Caravan of Courage* – won an Emmy award for best visual effects.

### *Starman*

Visual effects for *Starman* – including early scenes of an alien ship's arrival and the finale in which its earth explorer is rescued at a rendezvous point in the Arizona desert – had already been designed by director John Carpenter and his team by the time ILM and supervisor Bruce Nicholson signed on. Designs included a highly-reflective mothership, constructed as a shiny-black, domed model. Rotating rings on the ship were achieved by reflecting a spinning disk of neon lights onto its



surface. For shots of the massive ship descending, fisheye-lens shots of the desert, photographed from a helicopter, were projected onto a dome that was lowered on a motion control mount. Also featured were miniature helicopters matted into the background sky.

Miniatures were likewise employed for shots of a train moving through a desert landscape. Done as a latent image shot, photography of a miniature train against a painted backdrop was combined with a painting of the Las Vegas skyline to extend the image. ILM was also responsible for a 'powers of ten' shot, in which a lock of hair is shown in ever-increasing closeup, until its molecular structure is revealed. Mike McAlister shot five separate models motion control to represent each stage of the microscopic zoom-in.



*Micheal McAlister polishes the reflective surface of an alien spacecraft featured in Starman.*

### 1985 *The Goonies*

Only eighteen shots were required for *The Goonies*, a Steven Spielberg story – directed by Richard Donner – about a band of misfit kids that discovers an abandoned pirate's lair. Under the supervision of Micheal McAlister, ILM photographed matte paintings and miniatures that added to the scope of full-scale sets, then composited that footage – along with bluescreen elements of the actors – into live-action backgrounds. Matte paintings were also employed to fill out missing elements of a full-scale pirate ship – the *Inferno* – that had been built on stage.

At the end of the film, the *Inferno* sails out to sea, freed from its underground lair. The scene utilized a highly-detailed miniature of the ship, mounted on a gimbal to create a natural rocking motion, photographed bluescreen and composited into ocean backgrounds. The image was enhanced with wave mattes – produced by the animation department – as well as optically-induced haze.

### *Cocoon*

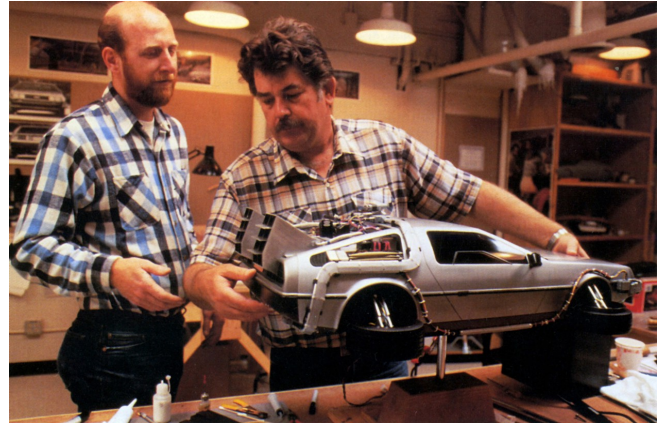
ILM and supervisor Ken Ralston were responsible for miniatures, matte paintings and optical effects in *Cocoon*, a Ron Howard film about an extraterrestrial rescue mission and its impact on a group of senior citizens. Benevolent aliens – actors in makeups conceived by Cannom Creations – were shot bluescreen at ILM. Ethereal glows were added in postproduction by the optical and animation departments. Scenes featuring flying aliens were shot high-speed and full-frame against bluescreen, then rephotographed via motion control and projected into live-action backgrounds. To create a spinning ball of light for a scene in which an alien engages in her species' version of lovemaking, ILM shot a rotating four-inch sculpture on a motion control animation stand, then added an animated vapor trail and glow. Interactive lighting effects on the actors and set were achieved both practically and via animation.

At film's conclusion, the aliens' mothership returns, hovering overhead and drawing up a boat and its waiting passengers. A three-foot spaceship model, equipped with moving practical lights, was shot motion control for the scene. Cloud tank material provided the stormy turbulence

accompanying the mothership's arrival. Shots of the airborne boat were accomplished with a model and stop-motion puppets. The spaceship's final ascent into the sky was realized with four glass-painted images, lined up in a parallel configuration, lit from behind and photographed motion control. Matte paintings – and a refurbished moon model from *Star Trek II* – also provided a view of the heavens through a telescope early in the film.

### *Back to the Future*

The first in what would become a popular trilogy of time travel adventures – all directed by Robert Zemeckis – *Back to the Future* featured only a handful of visual effects, supervised by Ken Ralston. Among them was the time travel effect itself – a stunning show of light and color that fell to the animation department. Parallel trails of fire that remain after the DeLorean time machine disappears were achieved practically, then enhanced with animation, with actors bluescreened into the shot. The car's flashy reappearance in a new time period was achieved through manipulation of a photo transparency on the animation stand.



Steve Gawley and Ira Keeler examine a model of the DeLorean time machine built for its final takeoff scene in *Back to the Future*.

ILM's remaining shots appear at the climax, as the time machine's drained power supply is recharged by a bolt of lightning during a storm. Lightning bolts for the sequence were animation effects. The final shot in the film has the DeLorean taking flight from a suburban neighborhood. A mechanized, fifth-scale replica of the car was shot motion control against bluescreen, then composited into a live-action plate. A separate liquid nitrogen element created exhaust, while animated shadows placed the vehicle more convincingly into the scene.

### *Explorers*

In the Joe Dante film, *Explorers*, three young boys set out in a homemade spaceship and find deep-space adventure. Alien beings were designed and built by Rob Bottin, while two dream segments were created with computer animation by Omnibus Computer Graphics. The remainder of the effects – approximately 140 shots – was assigned to ILM and visual effects supervisor Bruce Nicholson.

To effect a small force-field bubble floating in a basement laboratory, a plastic sphere was photographed under ultraviolet light. Later images of children trapped inside a larger version of the bubble were achieved by flying the young actors in front of a bluescreen and combining those elements with the bubble imagery. Two miniatures were employed for motion control shots of the makeshift spaceship in flight, the larger of which housed tiny, servo-mechanized puppets to represent the kids. Long shots of the craft flying over the neighborhood and town featured miniature sets, painted backdrops and matte paintings. A sculpted and painted relief map – filmed against a layer of fiberfill clouds – served as a background for the spaceship as it continues to rise above the terrain, while the earth visible below was realized as a matte painting. Additional models

constructed for the show included an alien dragster-type spaceship and a spider-like robot that was meticulously stop-motion animated.

For a dream flight at film's end, actors were mounted on maneuverable pylons and shot bluescreen. Composited behind them was a stylized landscape produced with an assortment of kodaliths and fiberfill clouds shot against black.

### *Mishima*

Lucasfilm joined with Zoetrope and Filmlink to bring *Mishima* – Paul Schrader's biography of Japanese writer Yukio Mishima – to the screen. Filmed in Japan and starring an all-Japanese cast, the picture dramatized segments from three of the author's novels. In a lead-in sequence, *Mishima's* ritualistic suicide was suggested through ILM imagery of blood on paper, optically composited with titles.

### *Amazing Stories*

For the NBC television anthology, *Amazing Stories* – produced by Steven Spielberg's Amblin Entertainment – ILM provided a shot for the show's recurring end credits of a suburban neighborhood transformed from day to night by the setting of the sun. Supervised by Paul Huston and Michael Pangrazio, the shot was accomplished on stage with a forced perspective street model. The lighting transition was achieved through the use of two computer controlled lighting setups.

### *Ewoks: The Battle for Endor*

As had *The Ewok Adventure* – the previous *Star Wars* television spinoff – *Ewoks: The Battle for Endor* won an Emmy for best visual effects. ILM again contributed a number of scene-setting matte paintings, as well as sequences involving stop-motion animation.

### *Enemy Mine*

*Enemy Mine* – directed by Wolfgang Petersen – featured an opening aerial dogfight supervised by Don Dow. Although much of the action was captured by the production team using full-size ships flown on wires, more intricate shots required spaceship miniatures, built by the ILM model shop and shot motion control. The matte department was also heavily involved, producing a number of latent image composites that helped to establish the alien planet landscape.

### *Young Sherlock Holmes*

For *Young Sherlock Holmes* – an Amblin production directed by Barry Levinson – ILM was enlisted to create three hallucination sequences, including one in which a stained glass knight leaps from a church window. Visual effects supervisor Dennis Muren and Pixar Computer Animation Group – at that time, a division of *Lucasfilm* – devoted months of research and development to the digital generation of a seven-foot-tall knight, the first three-dimensional, fully computer animated character to be featured in a full-length film. Final composites – comprised of the CG knight, animated shadows and a stained glass window matte painting – were printed out directly onto film by a revolutionary laser scanner.



Bird-sized harpies that attack another hallucinating victim were realized through go-motion. An armatured puppet, programmed to perform gross movements, was photographed bluescreen, with subtle articulations executed by hand between each frame of exposure. Rotoscope mattes eradicated the go-motion support rods from the bluescreen footage, while cel-animated shadows helped to tie the creatures into live environments. Young Watson's hallucination, taking the form of an advancing army of pastries, was achieved with rod puppets photographed both live on the set and on a bluescreen setup. Closeups of pastry faces were enlivened with cel-animated eyes.

Among the film's matte paintings was a moody nighttime shot of Holmes and Watson walking the streets of London. To achieve it, ILM had to extract a silhouette matte of the two figures and their shadows from a live-action plate, then bipack it with a painting. The painting was augmented with a foreground street miniature to sustain the illusion throughout the extended shot.

### Out of Africa

Opening scenes in *Out of Africa* featured a train traveling through a variety of East African landscapes. When the live-action train on location continued to break down, director Sydney Pollack turned to ILM and supervisor Micheal McAlister for an effects solution. McAlister shot background plates in Kenya for two weeks, then returned to ILM to oversee construction of a miniature train and track setup. The miniature was photographed bluescreen, under the supervision of Ken Ralston, then composited with McAlister's plates.

### 1986 *The Money Pit*

*The Money Pit*, directed by Richard Benjamin, required one 'fix-it' shot – a daytime exterior that the filmmakers wanted changed to a night scene. Optical tweaking of the original photography accomplished the transformation.

### Labyrinth

George Lucas served as executive producer on *Labyrinth*, a goblin tale directed by Jim Henson. Primarily a puppeteering feat for the Henson team, and a showcase for the talents of special effects supervisors George Gibbs and Richard Conway, the movie was visually supported by matte paintings rendered at ILM by Sean Joyce and Caroleen Green and photographed by Craig Barron.



Randy Dutra animates a beast of burden for the television special *Ewoks: The Battle for Endor*.



A human scientist transforms into the beastly Dark Overlord – animated by Phil Tippett – in *Howard the Duck*.

### *Howard the Duck*

Based on a popular underground comic book, *Howard the Duck* – executive produced by George Lucas and directed by Willard Huyck – was a stranger-in-a-strange-land story of an anthropomorphic duck accidentally beamed to earth from his home planet, lightyears away. Effects were supervised by Micheal McAlister. Howard himself was designed by Nilo Rodis-Jamero and realized by the ILM creature shop, which constructed suits and animatronic heads worn by performers.

The movie also featured a malevolent Dark Overlord – a makeup on actor Jeffrey Jones devised by Tom and Bari Burman. ILM visual effects, such as electrical charges emanating from the character, enhanced the makeup's effectiveness. A more fully-evolved beast – designed by Phil Tippett – was realized as a go-motion puppet. Also included in ILM's work were matte paintings employed to extend large-scale sets representing Howard's home planet.

### *Captain EO*

ILM ventured into the burgeoning arena of theme park film attractions with *Captain EO*, a seventeen-minute 3-D space adventure for Disneyland and Walt Disney World starring Michael Jackson, directed by Francis Ford Coppola and produced by George Lucas. Disney effects supervisor Harrison Ellenshaw oversaw some 150 effects shots, which included motion control spaceships, matte paintings, bluescreen photography, highspeed shots, traditional stop-motion, and even clay animation. Faced with a nearly impossible deadline, Ellenshaw was supported near the end of postproduction by an ILM team that stepped in to complete motion control model photography – specifically, shots featured in the opening space chase sequence.

### *Star Trek IV: The Voyage Home*

For *Star Trek IV: The Voyage Home* – directed by Leonard Nimoy – ILM and supervisor Ken Ralston limited the number of opticals and attempted to do as much in-camera work as possible. Among the major effects was a massive probe, built in a variety of scales by the model shop and equipped with practical lighting to facilitate in-camera matting. Old models were refurbished or modified, including the Enterprise – repainted and affixed with an 'A' to distinguish it from the original ship. The Klingon *Bird of Prey* and the intricate space dock model from *Star Trek III* were also recommissioned.

Painted backdrops and matte paintings were employed to establish Vulcan landscapes, as well as a sweeping view of Starfleet Command. A shot of a whale tank and its surroundings at the fictitious Cetacean Institute was realized as a composite of live-action, water plates and footage shot at the Monterey Bay Aquarium. Tumultuous storm conditions brought on by the approaching probe were achieved via a combination of cloud tank effects and a rotating formation of baking soda on black velvet. In keeping with the in-camera philosophy of the film, lightning bolts were achieved on stage by shooting rheostatted light bulbs.

ILM's evolving computer graphics department was tasked with a dream sequence in which a series of images reveals characters transforming from one to another. Digital representations of the characters were created by laser scanning the actors at Cyberware Laboratory, then feeding that data into ILM's computers.



At film's end, the *Bird of Prey* crash-lands in San Francisco Bay. A forced-perspective replica of the Golden Gate Bridge was erected over a shallow tank and photographed with wind and smoke to simulate storm conditions and obscure a painted backdrop. The ship was photographed separately via motion control.

### *The Golden Child*

Under supervisor Ken Ralston, ILM's primary contribution to Michael Ritchie's *The Golden Child* was the climactic transformation of a character into a winged demon. The sequence employed go-motion animation on a scale never before attempted – overseen by Phil Tippett, who remained on call at ILM, even though he had officially left the company to open his own shop. To achieve the frenetic look of documentary footage, ILM devised a field operable motion control system that could record camera shake on location, then repeat that hand-held-style movement during the bluescreen go-motion puppet photography. The transformation into the demon was initiated by rotating actor Charles Dance on a platform and shooting him against bluescreen. An animated burst of flame masked the switch from actor to puppet. The sixty-second transformation was the longest effects shot ever produced by ILM.

Stop-motion animation was employed for a light-hearted dance of an enchanted Pepsi can. Armatured cans were filmed against bluescreen or in-camera on a tabletop, then enhanced with cel-animated shadows. Scenes of a woman with a serpentine tail were achieved by photographing bluescreen elements of an actress, draped from the torso down in black velvet. A go-motion and rod-puppeted serpentine tail was then meticulously match-moved to the actress' gyrations. Rotoscope mattes resulted in an exact fit of the tail to the woman's waist.

Four matte paintings were rendered – two for establishing shots, and two to extend the scope of temple interiors. A shot of the temple nestled in a snowy mountainscape was achieved by filming a foreground miniature temple and multiple planes of glass paintings, into which live-action elements were rear-projected. A grandiose representation of hell was ILM's tour de force in the movie. The reveal of an infernal netherworld combined sixty-five elements, including bluescreen shots, a miniature set, rear-projected inserts and a multitude of matte and camera passes, all filmed motion control.

### 1987 *Star Tours*

ILM partnered with Walt Disney Imagineering in the making of *Star Tours*, an animatronic and simulator film ride – rooted in the *Star Wars* saga – in which vacationing passengers board a StarSpeeder shuttle and are taken on a hair-raising test flight piloted by a rookie robot. Effects art director Dave Carson and effects supervisor Dennis Muren orchestrated four and a half minutes of continuous effects footage simulating an uninterrupted view from the StarSpeeder passenger bay. The film was first developed in a full-length videomatic that employed cardboard cutouts and simple, wireframe computer graphics. The videomatic served as both a reference in the model photography and a basis for early programming of the motion base. Motion control photography of miniature sets, such as the launch station, an ice tunnel and the Death Star, followed. Sudden banking turns helped to mask cuts and make the film appear seamless.

### *The Witches of Eastwick*

Director George Miller and principals at ILM – including visual effects supervisor Michael Owens – agreed that sorcery sequences for *The Witches of Eastwick* should rely on visual trickery as little as possible. Effects were mandatory for some scenes, however, such as a rainstorm conjured up by the three witches early in the film. Liquid nitrogen, pumped through holes in black velvet, provided initial cloud elements that were composited into a blue sky. More threatening clouds were achieved by filming cotton attached to rotating aluminum tubes. Practical lights within the cotton tufts suggested lightning, an effect more fully realized with animation.

The animation department was also charged with executing a bizarre tennis game in which a physics-defying ball speeds up, slows down and makes strange, right-angle turns in midair. Even normal play became an effects assignment when it was discovered that the actors were not proficient enough at tennis to maintain a decent volley. The ball, mounted on a gimbal rig, was shot motion control, full-frame, then rephotographed on a pin-block and inserted into live-action plates. Motion control was also used for a scene in which Veronica Cartwright's character vomits a stream of cherry pits. Simulated vomit was pumped through a tube aligned to the live-action footage, then match-moved to the actress' mouth.

The transformation of Daryl Van Horne into a fifty-foot-tall demon employed puppet figures designed and built by Rob Bottin that were then photographed and composited by ILM. The model shop built elaborate miniatures for the sequence. In a subsequent scene, the giant Van Horne transforms into a baby-like demon – a rod puppet shot on the bluescreen stage. To endow the puppet with Jack Nicholson's facial characteristics, the head area was left largely featureless, and the actor's filmed image was projected onto the form. Animation created an aura around the creature, as well as a shrink-down effect to make it disappear in bursting-bubble fashion. ILM also provided matte paintings and latent image composites for establishing shots of Van Horne's palatial mansion.

### *Harry and the Hendersons*

Noted for Rick Baker's Oscar-winning makeup effects, *Harry and the Hendersons* – a comedy directed by William Dear – also featured a couple of ILM matte shots supervised by Chris Evans. For a scene in which Harry, the benign Bigfoot character, arrives at a freeway, live-action footage captured on Bay Area freeways was inserted optically into a painting depicting a surrounding forest. A bluescreen element of Harry was also composited into the scene.

### *Innerspace*

Dennis Muren supervised ILM's work on *Innerspace*, Joe Dante's film about a miniaturization experiment in which a test pilot is injected into a human body. Bluescreen footage of rod-puppeted submersible pods was composited with miniature sets representing internal body organs and passages. To suggest the liquid nature of the organic environment, miniatures were often shot in the ILM water tank, while dry-for-wet shots utilized dense smoke to simulate fluid surroundings. A battle between two pods transpires in the trachea area – an enlarged set piece used in conjunction with rod-actuated pod miniatures – and culminates with one pod plummeting into the acidic environment of the stomach. The scene employed a stomach model – complete with simulated acid and chunks of undigested food – that was filmed separately as a high-speed element. For a later

sequence within a woman's body, a sculpted fetus cast in translucent urethane was photographed floating in the cloud tank.



*Lorne Peterson attends to one of the beneficent flying saucers in Batteries Not Included.*

Effects outside the human bodies included half-scale characters inside a forced perspective car interior set. Brief interactive shots between miniaturized and full-size characters utilized half-sized puppets or double-sized busts. The use of forced-perspective sets, puppets and oversize props enabled ILM to complete the entire finale without resorting to opticals.

#### *Batteries Not Included*

*Batteries Not Included* – from producer Steven Spielberg and director Matthew Robbins – involves a small band of tenement dwellers on the losing end of a fight with city hall over plans to raze their building. Saving the day are two tiny flying saucers with anthropomorphic characteristics and remarkable healing capabilities. Effects supervisor Bruce Nicholson and crew devised saucer models capable of a range of expression. Principal models were equipped with radio control mechanisms to control eye and arm movements, while others were built to perform more specific actions.

Rather than have the saucers inserted optically during postproduction, Robbins wanted them flown through the set on wires to facilitate interaction with the actors. Shots that could not be achieved on set would be relegated to stop-motion or rod-puppeteering, overseen by animator David Allen. To ensure continuity of style between on-set footage and that filmed on a motion control bluescreen stage, a sophisticated flying rig that could be used effectively in both environments was developed. In the end, thirty percent of the flying saucer shots were achieved on set by a second unit under the direction of Joe Johnston.

#### *Star Trek: The Next Generation*

Television production schedules and limited budgets made video technology the only viable option for *Star Trek: The Next Generation*'s weekly slate of fifty-some effects shots. Photographed on film, effects elements were then transferred to video where they were manipulated electronically and outputted as final composites. Although not involved with the show on a weekly basis, ILM was engaged to construct a new Enterprise for the pilot and to provide reusable bluescreen elements, as well as multiplane starfield backgrounds. The company also contributed film elements – transferred to video and composited as needed – for the warp-drive effect.

#### *Empire of the Sun*

Steven Spielberg's *Empire of the Sun* required a mere handful of effects shots, supervised by Dennis Muren. For a wide view revealing the aerial bombing of a town, a foreground bluescreen element



Gordon Tate wrangles an animatronic ostrich built for the morphing sorceress scene in *Willow*.

was shot, then composited with a background consisting of miniatures and a painting. To simulate distant explosions, a lighting rig was devised that could be programmed to set off a series of flashes. ILM also contributed squadrons of computer generated airplanes, an atomic Shockwave and a wide aerial view of a stadium.

#### 1988 *Willow*

Ron Howard was engaged to helm the George Lucas production of *Willow*, with fantasy effects supervised by Dennis Muren, Micheal McAlister and Phil Tippett. A series of matte paintings combined with live-action plates and miniatures produced spectacular landscapes revealing Willow's village and lands beyond, as well as establishing shots of the evil Queen Bavmorda's castle. Glass paintings were rendered to represent castle interiors.

Nine-inch-tall brownie characters were accomplished either as inserted bluescreen elements or through the use of oversize sets. Reference footage obtained by shooting tiny cutouts on location was later used to scale and position the bluescreen characters into each frame through pin-blocking. Requiring an expansive space, the brownie shoot was executed at a vacant auto plant converted to a frontlit bluescreen stage. When even that proved too small for some walking and running scenes, a treadmill was employed.

Other characters included the fairy queen Cherlindrea and a two-headed, fire-breathing dragon. Cherlindrea was portrayed by an actress in a diaphanous gown, shot against black, with heavy backlighting and diffusion, suggesting an ethereal presence. The dragon was achieved through go-motion puppetry. Although most of the dragon elements were filmed bluescreen and composited optically into live-action plates, rear projection and in-camera compositing were applied wherever feasible for economy and speed.

The most innovative effects sequence occurs when a hexed sorceress is restored from possum to human form, going through a succession of transformations in the process. To achieve the effect, ILM's creature shop constructed animatronic goat, ostrich, turtle and tiger figures that were manipulated with rods to begin each successive segment of the transformation. With that practical kick-start, the transitions were completed and linked smoothly via morphing – a digital image processing technique introduced in the film. In a final battle between two sorceresses, a variety of stop-motion, animation and optical effects techniques were employed to create a dazzling display of supernatural mayhem.

#### *Star Trek Attraction*

Although the Universal Studios Tour *Star Trek* attraction was primarily a live-action presentation featuring large-scale set pieces and animatronics, incorporated in it was a brief film segment – supervised by Scott Squires – in which the Enterprise is attacked by a giant tentacled creature. The Enterprise model used in the *Star Trek* feature films was dusted off and photographed in conjunction with a mechanical creature, built and puppeteered by the ILM creature shop.

#### *Who Framed Roger Rabbit*

Directed by Robert Zemeckis, *Who Framed Roger Rabbit* was a major achievement in the integration of live-action and animation. Although the character animation would be done by teams of Disney



animators, it was up to ILM to incorporate it into the live-action. The effects work, supervised by Ken Ralston, entailed comprehensive plate photography and an unprecedented effort by the optical team.

Among *Roger Rabbits* innovations was its bold and near-continuous camera movement. Because nearly every scene in the movie would feature animation or effects enhancement, principal photography was shot almost exclusively in VistaVision, using a new VistaFlex sound-sync camera. An optical technique for adding appropriate color tinting to shaded areas and shadows blended the animated characters realistically into live-action scenes.

The Toon Town finale required the insertion of bluescreen elements into an all-animated environment. A video matting system facilitated the real-time compositing of live imagery from the bluescreen stage with storyboard sketches, providing vital reference for the positioning of actor Bob Hoskins within the frame. Great pains were taken to ensure that the lighting matched from bluescreen to animated settings. A final confrontation at the Acme Gag Factory employed a go-motion puppet, shot bluescreen, as well as set miniatures. More than a thousand opticals were ultimately completed for the show, amounting to fifty-seven minutes of film time.



Private eye Eddie Valiant is smitten by the sultry Jessica Rabbit in *Who Framed Roger Rabbit*, a film that broke ground in its innovative blending of live-action and animation.

The popularity of *Who Framed Roger Rabbit* led to the making of two cartoon shorts – *Roller Coaster Rabbit* and *Tummy Trouble* – each of which contained brief scenes of animation combined with live-action. ILM used the same optical techniques it had developed for the original movie to realize composites for the animated shorts.

### *The Last Temptation of Christ*

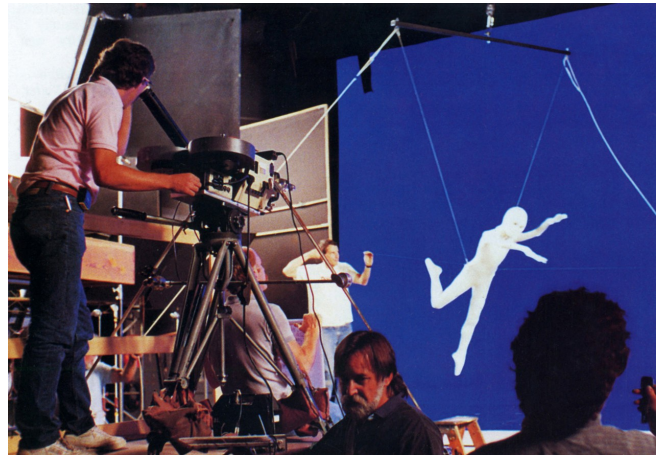
Martin Scorsese's controversial film. *The Last Temptation of Christ*, was hardly an effects extravaganza – but ILM's deft hand can be seen in a key scene in which Christ is confronted by a lion in the desert. Photographed separately, actor Willem Dafoe and the lion were split-screened to appear as if they were in close proximity.

### *Caddyshack II*

*Caddyshack II*, a comedy directed by Allan Arkush, featured such ILM touches as digital golf balls, forced perspective miniatures, golf course matte paintings and a mechanical gopher puppet. Michael Owens supervised, while Bill George served as visual effects art director.

### *Cocoon: The Return*

Daniel Petrie directed *Cocoon: The Return*, a production requiring the delivery of eighty-eight effects shots on a very tight schedule. Longtime ILM effects cameraman Scott Farrar stepped into a supervisory role for the picture, which featured animation, bluescreen and optical effects. Replicating the look established in the first film, ILM produced imagery of a transforming alien by photographing an actress, in a white bodysuit and mask, against bluescreen. Multiple passes with a new Mechanical Concepts camera created a glowing vapor on the bluescreen element. One pass consisted of a water ripple that was slip-synced to create vaporous movement; another was a fire element to give the extraterrestrial a bright orange, internally-lit appearance.



A performer in alien makeup and suit is flown in front of a bluescreen for *Cocoon: The Return*.

Because Brian Dennehy – one of the key members of the original cast – was not available for principal photography, the actor was filmed against bluescreen in Los Angeles and composited into the sequel's final scenes. The finale, in which characters transform into comet-like shapes and ascend to the mothership, was achieved with animation effects. Shots of the mothership from the first film were reused – although one new model was built and employed for a shot of the ship doors opening.

### 1989 *The 'Burbs*

Directed by Joe Dante, *The 'Burbs* opens with a 'powers of ten' shot that originates in space, moves in on the Universal Pictures globe logo, and finally descends into a suburban neighborhood. Overseen by Michael Owens and designed by Bill George, the sequence was shot in reverse, starting on a house and neighborhood miniature, then drawing back via motion control to reveal a series of matte paintings, a globe model, and, finally, painted star fields. The optical department precisely matched the last frame of one segment with the first frame of the next to effect smooth transitions between each setup.

### *Skin Deep*

*Skin Deep* a Blake Edwards farce, featured an ILM effects scene in which two men wearing glow-in-the-dark condoms do battle in a darkened bedroom. Conceived as a parody of the lightsaber duel in *Star Wars*, the sequence was supervised by Michael Owens. Dancers dressed in black were photographed going through a series of moves while holding onto appropriately-shaped flashlights.

The moving light footage captured on film was intensified to a lightsaber-like glow through optical enhancement.

### *Body Wars*

A simulator ride for Disney's EPCOT Center, *Body Wars* made use of the same flight simulator technology employed for the Star Tours attraction to take guests on an *Innerspace*-inspired journey through the human body. Sets representing internal organs and body passages were built by the ILM model shop, then photographed on stage with motion control banking moves that correlated to programming of the hydraulic motion base.

### *Field of Dreams*

Bruce Nicholson supervised ILM's involvement on *Field of Dreams* – a film directed by Phil Alden Robinson – producing ghostly images of legendary ball players that appear in a corn field. The shots were realized through traditional split-screen photography and optical dissolves. ILM also composited a bluescreen element of Kevin Costner with a day-for-night background, and implemented a cross-dissolve in which a child's baseball shoe transforms into a grown man's loafer.

### *Indiana Jones and the Last Crusade*

For *Indiana Jones and the Last Crusade* – third in the series directed by Steven Spielberg – ILM created a number of optical effects, supervised by Micheal McAlister. Matte department contributions included a painting to extend an establishing shot of a castle, as well as a pre-World War II representation of the Berlin airport. To live-action of an existing Bay Area airfield, a control tower, Nazi banners, vintage automobiles and appropriate signage were added. The silhouette of a fictional Middle East city at dusk was actually a series of cutout buildings made of photo-etched brass and sheet aluminum, surrounded by a matte painting. To realize a sequence in which an army tank goes over a cliff, a model tank was filmed bluescreen and composited with a matte painting of the precipice and ravine below.

A scene in which Indy and his father escape from a zeppelin in a biplane employed a miniature airship and plane that were shot separately under motion control, then composited optically. The subsequent battle with two pursuing Nazi fighter planes was achieved via a combination of full-size rigs and miniatures, while the crash of one into a mountainside tunnel was photographed on a quarter-scale set. The second plane's run-in with a flock of seagulls was accomplished by flying the model on wires – against a painted backdrop – and dropping feathered cross-shaped devices from above. To simulate the birds in flight, wind-up flying toys were released against black and photographed, then double-exposed into the scene.

The film's climax takes place in the Canyon of the Crescent Moon – a setting realized by combining live-action footage with a matte painting and miniature set. Within a temple located there, a misstep results in Indy's nearly falling into an enormous chasm. The up-angle shot was a matte painting combined with live-action filmed on a set built thirty feet above the floor of the ILM main stage. The temple sequence also had Indy stepping out onto an invisible bridge spanning a deep gorge. The five-shot scene was accomplished with matte paintings, foreground miniatures and a bridge model – all of which were combined with bluescreen footage of Harrison Ford. To create

Indy's shadow – not supplied by the bluescreen footage – a puppet was positioned on the model and stop-motion animated to replicate Ford's movements. The puppet was later split-screened out of the shot, leaving only the desired shadow.

At the end of the film, a character ages rapidly and withers away to skeletal dust. Conceived as one continuous shot, the effect required three articulated motion-controlled puppet heads revealing the character in advancing stages of decomposition. Morphing was then employed to blend the three-stage photography into a seemingly uninterrupted whole. The shot was the first-ever digital composite of a full-screen, live-action image.

### *Ghostbusters II*

ILM completed 180 effects shots on one of its most compacted schedules for Ivan Reitman's *Ghostbusters II*. The opportunity to create a new array of ghosts attracted visual effects supervisor Dennis Muren to the project. First to make an appearance are the Scoleri brothers, who emerge from a beaker of slime to wreak havoc during a courtroom scene. *The ghosts* were realized by the creature shop, with mechanical heads and suits fitted on performers flown on wires in front of a bluescreen. The bluescreen footage was projected onto distorting mirrorplex and rephotographed. Among other supernatural manifestations were a ghost nanny – shot both with an actor and a miniature rod puppet against bluescreen – and the belated arrival of the ghostly *Titanic* in New York Harbor. The latter shot was achieved with a ship model photographed in a miniature harbor setting. Disembarking ghost passengers were costumed actors shot against black and optically composited into the miniature photography. An ambulatory Statue of Liberty, featured in the film's finale, was portrayed by a performer in a suit, photographed in both miniature and bluescreen setups.

The finale also featured the demonic form of Vigo the Carpathian, portrayed by creature shop member Howie Weed in an elaborate prosthetic makeup. The materialization of Vigo's portrait, seen earlier in the film, was achieved by shooting actor Wilhelm von Homburg in front of a bluescreen, then matting the image over a miniature corridor built by the model shop. A handful of effects and characters from the first film were carried over to the second, including nutrona wand beams and ghost trap discharges created by the animation department, and a revamped Slimer actuated via remote-control servo motors and pneumatics.



*Crew members prepare one of the ghostly Scoleri brothers for a scene in *Ghostbusters II*.*

## *The Abyss*

Ambitious effects sequences in *The Abyss* – James Cameron’s film about an undersea oil drilling crew coming in contact with an alien culture – required the services of nine effects facilities, ILM included. Still in its infancy, the ILM computer graphics department matured quickly in response to the film’s unique challenges. Specifically, the story required a fantastical pseudopod water probe that could change into a variety of shapes. Effects supervisor Dennis Muren oversaw plate photography for the scenes, shot at an abandoned nuclear power plant in South Carolina. Data from the plate shoot was meticulously gathered and recorded so that the on-set environments could be replicated in the computer, allowing for accurate compositing of the CG pseudopod. The computer graphics team labored for eight months to produce twenty shots totaling seventy-five seconds of screen time.



*Aerial firefighting scenes in Always were filmed in-camera using airplane models flown on wires over blazing miniature sets.*



ILM also provided for a sequence – cut from the film, but restored for its ‘special edition’ – in which nonterrestrials issue a stern warning in the form of two-thousand-foot-tall tidal waves that rise on coastlines around the world, then freeze and slowly recede. Real waves were photographed, then brought to a standstill by holding key frames, with computer graphics employed to smooth the transitions. For shots of the standing waves, ILM filmed a miniature with various overlays, then optically enhanced the imagery.

### *Back to the Future II*

Key to the premise of Robert Zemeckis’ *Back to the Future II* were ILM visual effects created under the supervision of Ken Ralston. Built as a full-scale set, futuristic Hill Valley had a holographic shark lunging from a movie theater marquee to advertise the release of *Jaws 19*. The computer generated shark was composited optically since the complexity and number of elements in the shot would have consumed an inordinate amount of scanning time.

Other shots employed futuristic skyways and vehicles fabricated by the model shop. The fifth-scale DeLorean built for *Back to the Future* was remodeled extensively to allow for interior views, complete with fifteen-inch-tall, servo-controlled puppets. Bluescreen motion control photography of the time-traveling car and other flying vehicles was match-moved into a cloudy atmosphere that was part stock footage and part smoke machine clouds. A shot of the hovering DeLorean being struck by a bolt of lightning was provided by the animation department, with the car model hung on wires and marionetted from above.

Logistically complex sequences featuring actors in multiple roles required some extremely ambitious split-screen shots. To meet the demands, ILM developed the Vistaglide – a portable motion control dolly system with video playback that enabled the operator to record an ‘A’ pass, then split it and have it available for review as the ‘B’ pass was being filmed. Unlike previous motion control systems, the Vistaglide was virtually silent, allowing for on-set production sound that would not require extensive looping.

### *Always*

A number of sequences in Steven Spielberg’s *Always* featured aerial firefighters barnstorming over blazing forest fires. Under supervisor Bruce Nicholson, ILM produced effects footage to supplement the full-scale fire and stage process effects orchestrated by physical effects coordinator Mike Wood. Rather than shooting miniatures against bluescreen and compositing them optically, aerial



A stylized volcanic island was built for *Joe Versus the Volcano*.

sequence designer Joe Johnston opted for an in-camera approach, shooting large-scale model planes maneuvering over actual fire environments via an ingenious, truck-mounted crane rig.

Daytime exteriors of the flying planes were shot outdoors. For night shots, the model planes were flown over a scaled forest landscape built by the model shop in an abandoned steel plant. Fire on the miniature set was achieved with propane gas pumped through pipes from below. Suspended from a gantry was a computer-controlled marionette rig that allowed the model aircraft to pitch and bank and roll while traversing the run at speeds up to thirty miles per hour. High-speed approach shots that might have endangered the camera or its operator were accomplished safely by shooting the action reflected in mirrors. All of the film's sixty-some miniature flying shots were achieved in-camera and required no optical compositing or enhancement.

### *1990 Joe Versus the Volcano*

With effects supervision by Dave Carson, ILM enlivened John Patrick Shanley's stylized romantic adventure, *Joe Versus the Volcano*, using a variety of animation and optical effects. Among them were a number of fanciful matte paintings – including one of New York with its skyscrapers purposefully tilted off-axis. For a sequence in which a boat is tossed about in a storm, the ILM camera crew shot a model in a large wave-making tank at a San Diego research facility. Distant views of a surrealistic volcanic island, revealed through the clearing fog and later seen sinking into the ocean, were accomplished with a large-scale miniature adjacent to a water tank. For shots of the protagonists looking down into the fiery heart of the volcano, the actors were filmed against a bluescreen and composited with views of the volcano interior – in reality a vertical wind tunnel filmed at ILM with vapor coalescing and twisting like a cyclone inside. Backlit methocil was used to simulate the lava.

### *The Hunt for Red October*

Effects for *The Hunt for Red October* – director John McTiernan's Cold War techno-thriller set aboard U.S. and Soviet nuclear submarines – were awarded originally to Boss Film Corporation. But when creative differences arose, the assignment was turned over to ILM, along with all the models – built by Greg Jein – move tests and storyboards produced at Boss. The reassignment left ILM with only slightly more than three months to deliver fifty effects shots – an intense effort overseen by visual effects supervisor Scott Squires and effects director of photography Patrick Sweeney.

Mostly for expediency, the submarine models were shot motion control – but in-camera, within miniature settings, as opposed to bluescreen. The large scale of the models mandated an expansive stage area, set up in an abandoned warehouse. Aside from the large Red October model – which was mounted on a pylon – all of the submarines were suspended from highly maneuverable wire rigs attached to motorized crane arms. Deep-sea environments were simulated by smoke, then enhanced with computer generated particulate matter composited optically over the single-pass model photography. Bluescreen was employed for shots of homing torpedoes, with ambient water turbulence simulated by the CG department.

### *Back to the Future III*

When the original screenplay for *Back to the Future II* proved too elaborate and far-reaching for a single movie, Universal greenlighted a third installment – provided director Robert Zemeckis shoot

it back-to-back with the second. Ken Ralston was on board as effects supervisor throughout both projects.

With performers again playing multiple roles, elaborate motion control split-screen work was required. One of the most complex shots had actor Michael J. Fox passing a plate of food to himself. To accomplish the effect, a concealed motion control arm was attached to the platter so that its movement across the table and through the split could be accurately repeated.

An action set piece had the DeLorean – stuck in the Old West without fuel – being pushed by a locomotive in order to achieve sufficient velocity for its passage back to the future. While an authentic vintage train was secured for the live-action shoot, quarter-scale miniatures were also utilized. On rails set in miniature landscapes, train models were propelled up to twenty miles per hour by a pulley system. Bluescreen photography supplied elements for shots of characters dangling from the speeding locomotive. Final shots in the sequence reveal the DeLorean disappearing in an animated time-slice effect, with the train plunging headlong into a ravine. Six high-speed cameras recorded the action, staged with a train model and a detailed trestle and ravine miniature. The film concludes in the present with the appearance of a Jules Verne-inspired flying train – built both in full-scale by Michael Lantieri and as an elaborate articulated model by ILM.



Motion control split-screen trickery enabled Michael J. Fox to play both Marty McFly and his great-great-grandfather in *Back to the Future III*.

### *Die Hard 2: Die Harder*

ILM had only five months to complete forty effects shots for Renny Harlin's *Die Hard 2* – a thriller involving renegade soldiers taking over Dulles International Airport. Effects challenges for ILM, tackled by supervisor Micheal McAlister and crew, included the creation of a stormy nighttime air corridor, crowded with jets, and the terrorist destruction of three airliners. Large-scale model aircraft were flown on wires and filmed either on a small airstrip or against bluescreen. Crashes were achieved by loading the models with pyrotechnics and then flying them into the ground, automatically triggering the explosives. Footage of aircraft flying through storm clouds was created by suspending the models from cranes over wind-blown formations of vaporized mineral oil. Wires used in flying the models were removed digitally.

Bluescreen was used for the film's signature image – Detective John McClane ejecting himself from the cockpit of a parked C-130 just moments before its detonation. A special rig was devised to tumble actor Bruce Willis in an ejection seat in front of a bluescreen. Choreographed camera moves, coupled with precise compositing over a pyrotechnic background plate, created the effect of McClane being blasted up toward the camera as the aircraft exploded beneath him. For the final shot in the sequence, a quarter-scale puppet and parachute were tossed from a forty-foot crane and photographed high-speed.

The last shot in the picture begins in close on McClane, reunited with his wife, then pulls back to a wide reveal of parked planes, emergency vehicles and throngs of passengers and airport personnel. Achieved economically by digitizing a matte painting and inserting multiple live-action elements, the thirty-five-second shot represented ILM's most ambitious employment of digital matte painting techniques to date.

#### *Akira Kurosawa's Dreams*

ILM's effects contribution to *Akira Kurosawa's Dreams*, supervised by Ken Ralston, was somewhat minimal. For a scene involving the destruction of Mount Fuji, a collapsing miniature mountain was covered with sculpted baking soda, then photographed in multiple passes to create a surrealistic glow. For another scene in which a boy ventures from a sunlit field into an ominous setting of dark mountains, matte paintings were combined with moving clouds painted on glass. A rain element, achieved by photographing water droplets manufactured by a steam machine, was also added.

#### *Ghost*

*Ghost* a supernatural romance from director Jerry Zucker, featured effects work contributed by Boss Film Corporation, Available Light and several other effects facilities, with Harrison Ellenshaw acting as consultant. ILM provided more than fifty pass-through effects – ghosts moving through walls and other solid objects – achieved optically under the supervision of Bruce Nicholson. Zucker sought to create a more realistic and dimensional pass-through effect than had been offered in prior ghost movies. Complicating the assignment was a conceptual suggestion that the color and texture of any surface being passed through be bled onto the body of the ghost. Ultimately, a wide variety of techniques were instrumental in achieving the pass-through and bleed-through effects, including traditional rotoscoping and animation, motion control split-screens and bluescreen and green-screen photography. Both live-action and model backgrounds were employed. Among the miniature sets constructed and photographed were a city street and a highly detailed subway.

#### *The Godfather – Part III*

Francis Ford Coppola's *Godfather III* featured a scene in which gangsters ensconced in an Atlantic City high-rise hotel suite are massacred by automatic weapons fire emanating from a helicopter hovering outside. ILM provided a miniature shot to establish the helicopter and also enhanced the practically-realized mayhem inside the suite with optically composited smoke and debris.

#### 1991 *The Doors*

For *The Doors* – a biography of rock star Jim Morrison directed by Oliver Stone – ILM provided a matte painting for a hand-held shot out the back of a car, revealing young Morrison's view of a highway accident. The multiplane shot was assembled on the Automatte. Another painting appeared in a scene of Morrison hallucinating in the desert.

#### *Switch*

Supervised by Michael Owens, effects for the Blake Edwards comedy, *Switch*, were limited to a sequence in which a character finds himself in purgatory – represented as a black void, broken by an intense light that pulsates with the voice of God. Actor Perry King was photographed against

black, then pin-blocked to make him appear smaller in the void. The God-light was achieved by shooting artwork on an animation effects camera.

### *Hudson Hawk*

*Hudson Hawk* – a film by Michael Lehmann – featured approximately thirty ILM effects shots, with Michael Owens acting as plate supervisor and John Knoll overseeing postproduction activities. Among the shots were a number of digital composites of a miniature, motion control glider. A large set representing a gold machine was also filmed and then optically composited, together with animation elements, to produce a rainbow effect. ILM also shot and composited bluescreen elements of Bruce Willis for a scene of his character jumping from a castle wall, as well as shots of Willis and Andie McDowell in a hang glider that were assembled digitally.

### *Backdraft*

Assuming that the majority of firemen-in-peril shots for *Backdraft* would have to be realized as optical composites, director Ron Howard enlisted ILM and visual effects supervisor Scott Farrar to oversee the effects work. However, due to the skill and ingenuity of special effects supervisor Allen Hall and cinematographer Mikael Salomon, ILM's ultimate contribution to the show consisted of only five shots. In addition to matting into background plates the practically-realized 'brain flame' – an unusual, malevolent fire form featured throughout the movie – ILM also provided a quarter-scale rooftop model and foreground matte painting for a wide aerial view of a burning chemical plant. The rooftop model, loaded with miniature pyrotechnic charges triggered from a computerized control board, was filmed undercranked to render the explosions in scale. Figures running on the roof were shot separately and composited digitally through difference matting – an innovative technique that allowed a matte to be pulled as long as there was a difference in brightness between an object and its background. All of the shot elements were scanned into the computer, manipulated, then output as a finished composite.

### *The Rocketeer*

ILM alumnus Joe Johnston directed *The Rocketeer*, a comics-based film set in the golden age of aviation. Although Johnston accomplished as many effects as possible through practical means, ILM was tasked with a full optical slate, as well as the building and photographing of miniatures ranging from an eighteen-inch flying Rocketeer to a thirty-four-foot zeppelin. Supervising the visual effects effort was Ken Ralston.

Central to the story was a rocketpack, built by the practical effects team and rigged to spew live flame, later enhanced by the ILM animation department. More than thirty shots of the Rocketeer in flight were achieved with a puppet mounted to a programmable pylon. While the character's body movements were produced via stop-motion animation, fluid flying maneuvers were effected through the use of a track-mounted camera capable of programmable moves on all axes. The puppet figure was composited into live-action plates or backgrounds comprised of miniatures and matte paintings.

The picture comes to a climax aboard a Nazi zeppelin. Though portions of the eight-hundred-foot-long airship were constructed full-scale, views revealing the entire vessel were accomplished in



miniature. A villain's fiery fall from the zeppelin was accomplished as an optical composite of live bluescreen elements and animated flame effects. His crash-landing on the 'Hollywoodland' sign – altering it to its current configuration – required the construction of a tenth-scale hillside set rigged with pyrotechnics so that the tail end of the sign would collapse on cue. Miniature pyro was also employed for shots of the zeppelin's incendiary demise. The finale of the sequence – in which characters are rescued from the burning craft by Howard Hughes piloting an autogiro – required a multi-element composite consisting of a matte painting background layered over with high-speed pyrotechnics, a motion control autogiro model and bluescreened actors.

### *Terminator 2: Judgment Day*

With *Terminator 2: Judgment Day*, director James Cameron conceived a film of such grand proportions that its effects work had to be divided among four teams. The ILM contingent – working under Dennis Muren – was tasked with creating shots of the liquid metal T-1000 terminator in his most fantastic incarnations. The assignment required a major expansion of the CG department, with animators and software engineers hired from all over the world and millions of dollars invested in new hardware and software.

During principal photography, an ILM film crew was present to shoot Vistavision plates. Because of the limitations imposed by computer techniques that were still new and relatively untested, most of the plates were shot locked-off. Specific scenes requiring camera moves were photographed with a motion control field recorder so that the on-set moves could later be read into the computer and repeated exactly. Extensive measurements were taken to aid the effects team in replicating sets in the computer and positioning their CG character within live backgrounds.

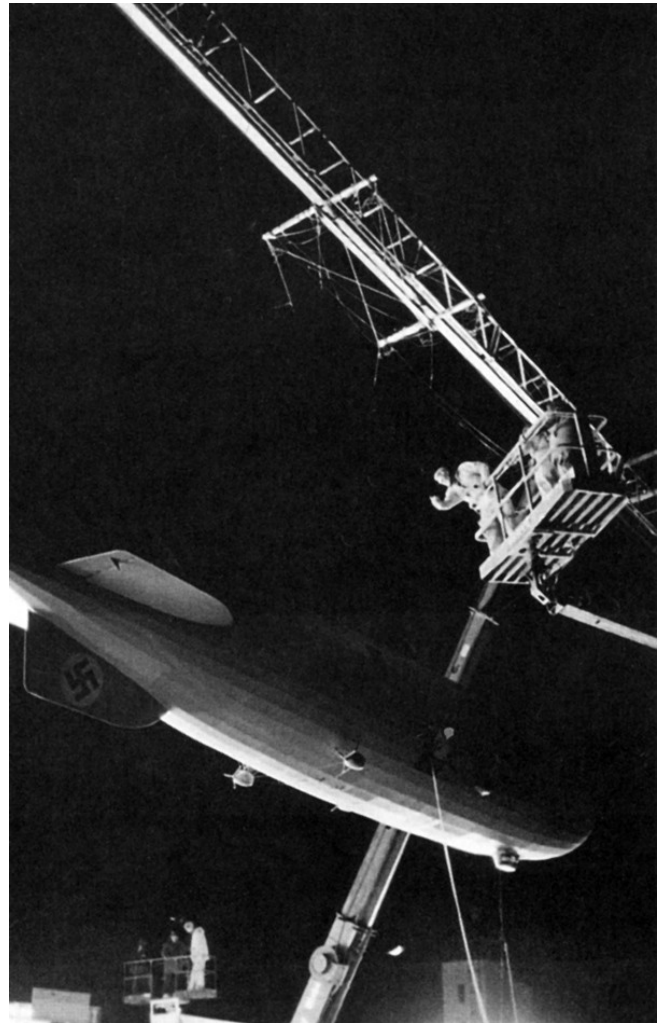
Transformation of the T-1000 into his predominant human form was a four-stage event. To define each, the model shop sculpted a series of eighteen-inch maquettes. Extensive reference material was acquired by photographing actor Robert Patrick – with a grid painted on his body – performing actions that would be required of his computer generated counterpart. Patrick was also scanned at Cyberware Laboratory to give the CG team basic data from which to build their computer model. Because of the reflective nature of the liquid metal terminator, CG shots had to incorporate reflections, achieved by shooting still photographs of the surrounding scenery, scanning those photographs into the computer and compositing them with the CG imagery. Among the most complex scenes was one inside a helicopter cockpit in which the T-1000 had to speak a line of dialogue. Sequential laser scanning produced digital imagery of Patrick forming specific facial articulations – imagery ultimately used to achieve proper lip-sync with the computer generated character. Morphing was employed for a final scene in which the T-1000 cycles through his various physical forms as he is destroyed in a vat of molten steel.

In addition to creating the liquid metal terminator, ILM was responsible for computer generated shots of lethal blades extending from the T-1000's arm, as well as the closing of bullet hits and other massive wounds achieved as makeup effects by Stan Winston Studio.

### *Space Race*

ILM collaborated with Showscan on *Space Race*, a simulator ride film written and produced by Ned Gorman from an original story by Dennis Muren. Scott Squires directed and served as visual effects supervisor. Because the company retained complete creative control, ILM was able to produce the five-minute film on a very low budget. Cost efficiency was also ensured by the re-employment of old models and spare parts gathered from the model shop. Motion control photography provided POV images of a futuristic racetrack, spectators and racing spaceships. In keeping with the high-resolution Showscan format, *Space Race* was shot in Vistavision at sixty frames per second. The film, which played at Showscan theaters worldwide, was one of ILM's last all non-digital productions.

### *Star Trek VI: The Undiscovered Country*



*A miniature Nazi zeppelin is readied for its fiery demise in The Rocketeer.*

Purported to be the final mission of Captain James T. Kirk and the starship Enterprise, *Star Trek VI* – directed by Nicholas Meyers – attempted to give the original crew an appropriately grand sendoff. Effects for the production were spearheaded by supervisor Scott Farrar.

To curtail costs – a studio mandate prompted by *Star Trek V*'s poor boxoffice showing – the producers streamlined effects sequences and ordered, the reuse of existing ship models, some of which were more than a decade old. Among the new models authorized were a suborbital shuttle seen early in the film, a small section of the spacedock and an enlarged Enterprise dish, built specifically for a shot of a photon torpedo impacting the ship. Miniature sets included one used in conjunction with live-action plate photography of the Golden Gate Bridge – for an establishing shot of Starfleet Headquarters – and a miniature courtroom to augment a full-scale partial set.



*Steve Reding and Brian Van't Hul prepare to photograph a dual-painting view of London for Hook.*

The movie opens with a massive explosion – achieved with computer graphics – that sends a lethal shockwave of energy and particulate matter through the star system. A shot of the starship *Excelsior* being engulfed by the shockwave was achieved by scanning motion control photography of the ship model into the computer system where it could be manipulated to interact with the digital imagery. Deviating from the approach employed in previous outings, both *Excelsior* and *Enterprise* models were filmed with separate key light and fill light passes, enabling the optical department to create varying levels of contrast.

For an assassination scene aboard a Klingon flagship, actors were photographed in wire rigs that were later removed digitally. The ILM CG team contributed globules of Klingon blood floating in the weightless environment. Enhancing the digital imagery were reflections mapped onto the drifting blobs and interactive shadows cast onto actors in the scene. Rips appearing in the uniforms of some of the characters as a result of phaser fire were also created digitally.

While the wide variety of aliens featured in the film were realized by the production's makeup effects crew, morphing techniques were applied for the transformations of a shape-shifting Chameloid. Footage of different actors playing permutations of the character were scanned into the computer, then morphed to create smooth transitions from one to the next.

### *Hook*

Supervised by Eric Brevig, the visual effects load for *Hook* – Steven Spielberg's epic retelling of *Peter Pan* – grew sixfold from start of production to end.

More than twenty highly detailed matte paintings were rendered to extend the scope of full-scale settings. Many had live-action elements – such as waterfalls, breaking waves and spectacular sunsets – strategically rear-projected into designated areas. For a scene in which Peter is hoisted out of the ocean in a giant clamshell and lifted into the Nevertree, a sixteen-foot miniature tree was shot against a painted backdrop.

To accomplish flying shots and scenes with *Tinkerbell*, an ILM bluescreen unit was dispatched to Sony Pictures Studios to work directly with the first unit – a complication mandated by the production's short schedule and Spielberg's intention to direct Julia Roberts' bluescreen performance as *Tinkerbell*. To give the tiny fairy an appropriate sense of mass, the actress or her stunt double were photographed with an undercranked camera, requiring that elaborate steps be



An invisible man plays tennis in *Memoirs of an Invisible Man*.

taken to make the character's mouth movements appear to be in sync with recorded dialogue. *Tinkerbell's* fluttering wings were actually nine-inch plastic devices built by the model shop and photographed separately. Go-motion animation created their flapping movement. The wings were then match-moved to align correctly to Roberts' body in the plate photography. Animation and optical techniques supplied the fairy's yellowish glow. Pixie dust was a combination of particles rendered by the animation department and computer animated dust trails.

For Peter's exuberant first flight over Neverland, bluescreen elements of Robin Williams in a flying rig were combined with two layers of stage clouds, computer generated shadows and an expansive matte painting of the island. To suggest a natural perspective shift in the flat Neverland painting, the island rendering was scanned into a computer and then texture-mapped onto a three-dimensional computer model. Wires used in all of the flying shots were removed digitally.

### *1992 Memoirs of an Invisible Man*

John Carpenter's *Memoirs of an Invisible Man* employed seventy effects shots to sell the illusion of a wholly or partially invisible man interacting with his environment. Although a range of techniques was utilized by supervisor Bruce Nicholson and crew – including bluescreen photography, stop-motion, puppeteering, motion control and optical compositing – some of the most accomplished shots were achieved digitally.

For a scene of the invisible man playing tennis, an actor was shot wearing a blue bodysuit beneath tennis garments. In digital, the blue areas were replaced with 'clean' backgrounds filmed during a second pass without the actor. The ILM Vistaglide camera enabled precise repeatability of camera moves during multiple passes. Digital paint and animation work filled in obscured areas of clothing – such as the inside portions of the tennis shorts – that would be revealed if they were indeed being worn by an invisible man. All of the invisible man shots were composited digitally.

### *The Young Indiana Jones Chronicles*

George Lucas endeavored to bring the high production values of the *Indiana Jones* feature films to television with *The Young Indiana Jones Chronicles*. Though Western Images was commissioned to provide digital effects for the series, ILM lent support, most often in the form of digital matte paintings that, when composited with live-action photography, created exotic locations without the hassle and expense of transporting a full cast and crew.

### *Death Becomes Her*

Effects supervisor Ken Ralston rejoined with director Robert Zemeckis to realize *Death Becomes Her*, a black comedy about two middle-aged women who discover a youth-restoring potion. Among the film's effects is an opening tilt-down from the New York skyline to the entrance of a theater. The upper levels of the theater, the marquee and a city skyline comprised of forty some buildings were all built in miniature for the shot.

A miniature was also employed for an establishing view of the Countess Lisle Von Rhuman's gothic mansion. For atmospheric effect, the model was filmed on a smoke-filled stage, with rain and lightning added optically. Additional mansion rooftop miniatures and a fourteen-foot mansion



model configured specifically for down-angles were built for later scenes. Backlit transparencies were positioned behind windows to suggest illuminated mansion interiors.

Among the bizarre images called for in the story were shots depicting Madeline Ashton with her head twisted around backwards on her body – the result of a fall down a flight of stairs. When attempts to accomplish the effect with prosthetic makeup proved unsuccessful, the gag was relegated to the computer graphics team. Both Meryl Streep and a double were photographed wearing a blue mask to allow for isolation and replacement of the head area. The actress' uncovered head was then photographed bluescreen and 'attached' in a backwards configuration on the headless body. A prosthetic neck piece sculpted by the makeup team and digitized into the computer system provided the join between head and body.

Some shots of a gaping gunshot hole in the torso of Helen Sharp were achieved by optically grafting Goldie Hawn's head onto a puppet built by Amalgamated Dynamics. Others were accomplished by using a combination of digital and optical techniques.



*A tyrannosaurus rex attacks a tour vehicle in Jurassic Park – the film that elevated computer generated imagery to a new plateau.*

#### *Alien Encounter*

*Alien Encounter*, a simulator attraction, was co-created for Japanese theme parks by ILM and Showscan. Director and effects supervisor John Knoll crafted a five-minute film simulating the view from inside an experimental hovercraft. The ILM team worked to blend live-action, motion control model photography and bluescreen photography. The film also included a computer generated alien probe.

#### *1993 Alive*

*Alive* – Frank Marshall's film adaptation of a true-life story about a young rugby team stranded in the Andes – featured a horrifically realistic plane crash realized by the ILM effects team, under Scott Farrar's supervision. Aerial plates to be used as backgrounds for composite shots employing model airplanes were filmed by Farrar and a small film crew over the Canadian Rockies.

For an opening *Star Wars*-style shot of the airplane flying slowly over camera, an eight-foot-long plane model was constructed and photographed motion control on the ILM stage. Since bluescreen photography of the shiny model would have been problematic, the plane was first shot against black. The model was then repainted black and shot a second time against white. An adequate matte was thus derived. Another plane model – an eight-foot breakaway version – was employed for subsequent shots of the airliner impacting with the mountain. Over a set constructed in the ILM parking lot, the model was hung from a tower rig and crashed into a mountain model. All wires and rigs were removed digitally. Views from the crashing plane's cockpit were simulated by shooting the actors and a cockpit mockup against bluescreen, then compositing the appropriate aerial photography into the scene. Bluescreen footage of stunt people in mechanically rigged airline seats

was combined with aerial backgrounds for shots of passengers falling out of the doomed plane as it breaks apart in midair.

### *The Nutcracker*

The film of George Balanchine's ballet, *The Nutcracker*, was shot primarily as if the audience had been brought onto the stage. Two sequences, however, required effects that were beyond the scope of what could be achieved practically. One featured a Christmas tree that grows to tremendous height. ILM and supervisor Eric Brevig built and photographed a four-foot mechanical tree model that was rigged to expand to fifteen feet. The model was shot motion control against a background and floor surface built to replicate the on-stage environment. Then it was composited into the film. ILM also created shots of a sleeping child atop a bed that flies about during a scene-change interlude. Miniature set pieces were built and then composited with bluescreen elements of the sleeping youngster and bed.

### *Fire in the Sky*

For *Fire in the Sky*, director Robert Lieberman's allegedly fact-based drama of an alien abduction, ILM relied on inexpensive practical techniques to produce a nearly thirteen-minute sequence that reveals the aliens onboard their ship. Both the ship interiors and the aliens themselves were realized by supervisor Michael Owens and his team.

Fabricated in the creature shop were six full-scale alien puppets articulated variously through rods, cables or radio control. The model shop, meanwhile, made a number of full-size and forced perspective sets representing the ship interiors. One set, seen in a shot of the aliens dragging their hostage down a long hall, was equipped with a winch and pulley system to propel the puppets. A sense of weightlessness in the photography was facilitated by mounting the camera on a remote unit that allowed for multi-axial rotation.

### *Jurassic Park*

Years of commitment to the development of digital technology came to fruition with *Jurassic Park* – Steven Spielberg's blockbuster film about genetically engineered dinosaurs. Approached in a collaborative spirit akin to that of *Terminator 2*, *Jurassic Park* featured both mechanical dinosaurs – designed and executed by Stan Winston Studio – and ones that were wholly digital creations generated at ILM by supervisor Dennis Muren and his crew. Phil Tippett, another partner in the project, worked with ILM in establishing animation criteria and devising a hands-on input device so that stop-motion animators could translate their tactile performance skills to computer animation.

Although Spielberg went into the production intent upon achieving much of the dinosaur footage mechanically, with the rest accomplished via go-motion puppet animation, ILM's rough CG test of a walking tyrannosaurus rex convinced him to scrap the go-motion work entirely and dedicate his film's resources to the development of computer generated dinosaurs. The most daunting aspect of the project was that, for the first time, the CG team was asked to digitally simulate organic creatures photorealistically, with authentic-looking hide coloration, texture, musculature and movement – a much taller order than creating a fantasy water probe or a metallic man. Hardware was upgraded, software was developed, and additional personnel were hired. Extremely complex

digital dinosaurs were built and animated – with the help of new software programs – and equally detailed texture and bump maps were rendered.

Ultimately, ILM achieved shots of dinosaurs at a watering hole, a brachiosaur feeding from a treetop, a stampeding gallimimus herd, a T-rex attack on a tour vehicle – intercut with Winston's full-scale mechanical construct – and a scene in which it chases a jeep. Midway through principal photography – his confidence in the computer animation running high – Spielberg added a CG finale in which two velociraptors engage the T-rex in battle. Tippett Studio tackled the remaining shots – most involving a pair of raptors stalking two children in a kitchen. In all, fifty-seven CG shots were completed – a staggering number considering the labored state of the art at the time.

#### *Last Action Hero*

Featuring characters and action sequences that were intentionally over-the-top, director John McTiernan's *Last Action Hero* required effects that were similarly overblown. The lion's share of the massive effects slate was taken on by RGA/LA, with a number of other firms also contributing. ILM's minimal involvement consisted of thirteen digital wire removals.

#### *Rising Sun*

*Rising Sun* – a Philip Kaufman thriller about a murder within a Japanese-owned corporation – featured a high-tech cover-up in the form of doctored surveillance camera footage. ILM effects supervisor Mark Dippé and effects art director Ty Ellingston created the brief film that figures prominently in the storyline, actually performing the film doctoring that is ultimately uncovered by the movie's fictional characters. The murder scene was shot in film, then transferred to digital video for manipulation on a Harry, where the image of the murderer was removed and replaced with that of another character. Shadows were incorporated to obscure the real murderer's image.

#### *Manhattan Murder Mystery*

In what was dubbed a '911' call, *Manhattan Murder Mystery* director Woody Allen sought ILM's help when he discovered a body microphone clearly visible on his person in one of the movie's completed scenes. The digital team painted out the obtrusive mike frame by frame.

#### *Meteorman*

Crucial to *Meteorman* – Robert Townsend's comic fantasy about a teacher who uses his newfound superpowers to clean up a ghetto neighborhood – were 117 ILM effects shots, supervised by Bruce Nicholson. Digital techniques were used to realize flying shots of the acrophobic character. Physical effects coordinator Al DiSarro attended to the practical flying gags, setting up wire rigs on location. Visible wires were removed digitally by ILM. More complicated flying setups utilized bluescreen elements of the actor, composited with Vistavision background plates shot with the Vista-flex motion control camera. Bluescreen was also implemented to create a stylized fight between *Meteorman* and a trio of street thugs. Modeled after a Popeye cartoon fight, the street brawl consisted of streak photography shot on an animation stand, then combined with live background plates and bluescreen footage to create the effect of the superhero simultaneously pummeling all three of his adversaries.

The green glowing meteor that gives the character his superpowers was realized in a variety of ways. In deep space, the meteor was simulated with a piece of sculpted plastic, illuminated from inside with a green-filtered light. A second version was created by coating a tin sphere with a pyrotechnic material that burned green. Shots of the meteor striking Townsend's character featured a three-dimensional computer generated image.

#### *Schindler's List*

In the face of studio trepidation, director Steven Spielberg chose to photograph all but the beginning and ending scenes of his much-honored film, *Schindler's List*, in black-and-white. Scenes featuring a little girl – in brilliant red against the documentary-style starkness of the surrounding footage – were also filmed in color, then desaturated by ILM to match the black-and-white stock. Extensive rotoscoping was required to hold out the color image of the girl.

#### 1994 *The Hudsucker Proxy*

*The Hudsucker Proxy* – a rags-to-riches story from filmmakers Joel and Ethan Coen – required miniatures, digital composites and some ingenious special effects rigs to realize its New York retro style. The effects effort was supervised by Micheal McAlister – formerly of ILM, but now a freelance visual effects supervisor – who turned to his alma mater for the creation of three transligh screens to quickly and economically simulate background buildings behind miniature city sets. ILM matte painters Yusei Uesugi and Paul Huston artfully assembled photographs of existing buildings into digital matte paintings that were filmed out to eight-by-ten negatives. Those negatives were then made into large translighs by Pacific Title & Art Studio.

#### *Maverick*

*Maverick*, a Richard Donner film based on the classic television series, featured two effects shots realized by ILM. Presented with a live-action plate of a riverboat moving through an inappropriately modern-looking area, the matte department's Bill Mather rendered a painting to create a period western town along the riverbanks. People around a campfire were filmed bluescreen and added to the shot as a foreground element. Another effects shot, executed by CG supervisor Carl Frederick and animator Rob Coleman, was required for a scene in which Mel Gibson throws down an ace of spades onto a table, tumbling a stack of chips. After more than fifty unsuccessful takes during principal photography, an exasperated Donner turned the scene over to ILM. A CG playing card and chips were built and animated, with shadows incorporated to tie the objects into the live-action plate.

#### *The Flintstones*

Supervisor Mark Dippé headed the computer graphics production of a host of whimsical prehistoric creatures for director Brian Levant's screen version of *The Flintstones*. Among the stylized characters were lumbering brontocranes that labor in the Slate & Company rock quarry. While closeups of the brontocranes were achieved with a full-size animatronic rig devised by Jim Henson's Creature Shop, full-body long shots were computer generated. Dino, the Flintstones' hyperactive pet, was also realized through both mechanical and digital means. Entirely computer generated were a

pterodactyl that acts as a prehistoric airplane and Loch Ness-type monsters seen frolicking in a lake.

Although the movie was decidedly lightweight in subject matter, it required the CG team to wrestle with an obstacle that had long plagued computer animators – the generation of photorealistic fur. When a man-in-a-suit approach to Kitty – the Flintstone cat – failed to impress, ILM took on the task of creating a fur-covered CG character. After much trial and error, a fur program was developed that was a sophisticated blending of modeling, animation and rendering techniques.

In addition to character work, ILM provided a hilltop view of Bedrock and a wide nighttime shot of a Stonehenge-inspired nightclub. The digital team also performed some of its most ambitious wire and rig removals, including one in which an entire crew of puppeteers was replaced with more suitable surroundings.

### *Wolf*

Though primarily a makeup and animatronics show, Mike Nichols' *Wolf* also featured visual effects provided by RGA/LA and Sony Pictures Imageworks. ILM's involvement was purely consultational, with Scott Farrar and Eric Brevig offering effects newcomer Nichols suggestions as to how the visual effects sequences might best be realized.

### *Baby's Day Out*

Effects artist Patrick Read Johnson directed *Baby's Day Out*, a John Hughes production about a baby who escapes his kidnappers and sets out into the dangerous world by himself. The mayhem that ensues was achieved, in part, by the ILM effects team. So as not to imperil the baby, the child was shot bluescreen on stage at ILM, then digitally composited into either live-action, miniature or 3-D computer generated backgrounds. Supervisor John Knoll oversaw the work.

### *Forrest Gump*

Again calling upon effects supervisor Ken Ralston, director Robert Zemeckis tasked ILM with placing *Forrest Gump's* title character squarely into historic events and into contact with 20th-century icons. The effects were realized by altering existing documentary and archival footage, then inserting bluescreen photography of actor Tom Hanks. In addition to matching action and camera moves in the archival footage – invariably shot hand-held or with unstable cameras – the digital artists had to simulate emulsion grain and incorporate it into the pristine bluescreen photography. Several scenes required that words be put into the mouths of the historical figures. Mouth movements were produced through a combination of morphing and digital painting techniques.



Early scenes of Forrest running for his college football team required ILM to extend the size of the stadium – adding second and third tiers – and to multiply the number of spectators by filling in the stands with digital replications of the original modest crowd. For a later scene in which Forrest speaks at an anti-war rally in Washington D.C., a crowd of only one thousand extras was multiplied a hundredfold and digitally placed along the Reflecting Pool in front of the Lincoln Memorial.



*Digital technology allowed bluescreen elements of Tom Hanks to be incorporated seamlessly into historical newsreel footage in Forrest Gump.*

ILM also sold the illusion of actor Gary Sinise as a double amputee. While some shots were achieved through standard gags – such as having Sinise sit on his knees in a wheelchair with a false bottom – a number of scenes relied on digital technology to depict the character's disability. For such scenes, Sinise wore stockings made of bluescreen material so that mattes could be generated to remove the lower part of his legs. Anything obscured by the actor's blue-stocked legs – flooring, furniture, even moving objects – had to be pieced together and digitally filled into the hole left in the background by the matte.

A white feather dancing randomly through a blue sky was an image that both began and ended the film. To achieve it, a feather was manipulated by monofilament and photographed bluescreen, nearly full-frame. That element was then choreographed and composited into background plates shot from a crane.

### *The Mask*

Visual effects supervisor Scott Squires and animation directors Steve Williams and Tom Bertino headed up ILM's efforts for *The Mask*, a Jim Carrey vehicle, directed by Charles Russell. Freed from the restraints of photorealistic effects, the traditionally-trained animators were encouraged to return to their roots and create outlandish, Tex Avery-style animation for nearly ninety computer generated shots. Among the cartoon gags was a shot of Stanley Ipikiss jumping from an upper-story window and landing flat as a pancake on the pavement below. As *The Mask*, his love-struck response to a sexy lounge singer manifests itself first in eye-popping and jaw-dropping, then a full facial transmutation into a whistling wolf.

A signature effect seen throughout the film was a swirling vortex produced by *The Mask* as he zips from place to place. The digital vortex consisted of a spinning core that was texture-mapped with photography of Carrey and encircled by animated concentric rings. A lengthy sequence featuring Stanley's dog – in superhero mode – required ILM to substitute the real animal's head with a cartoonish CG replacement intended to suggest a beefedup, stylized Jack Russell terrier.

### *Radioland Murders*

George Lucas executive produced and conceived the story for *Radioland Murders*, director Mel Smith's movie about the chaotic debut of an old-time radio network. As a means to cut production

costs, visual effects supervisor Scott Squires and crew employed techniques developed by Lucas for *The Young Indiana Jones Chronicles* to build sets or fill in missing walls and ceilings within the computer. Entire locations were created through digital matte paintings combined with miniatures. In addition to digital set construction, the movie featured extras cloned in the computer to create bigger crowds – resulting in personnel and wardrobe budget savings. ILM's proprietary real-time compositing system, Sabre, was instrumental in the completion of more than a hundred digital effects for the film.

### *Star Trek Generations*

Although *Star Trek Generations* was arguably the most ambitious of the *Star Trek* feature films, Paramount Pictures tightly restricted its budget, forcing director David Carson to explore creative alternatives for the movie's effects sequences. An ILM team – comprised of co-supervisors John Knoll and Alex Seiden and art director Bill George – was engaged to provide computer generated effects and model photography. Among the CG effects was the Nexus energy ribbon – created through the manipulation of five separate computer models – the implosion of a doomed sun, and the decloaking of the Klingon *Bird of Prey*. Also featured was a view of Veridian III from space – accomplished by texture-mapping digitized photography of acid-treated sheet copper onto a computer generated globe – and a computer generated Enterprise D that was stretched to realize a three-dimensional warp speed effect.

To conserve resources, previously used models were reemployed. The ILM model shop thoroughly refurbished the television Enterprise D model for its big-screen debut and – for a shot of the Enterprise B in drydock – resurrected a retired drydock miniature, removing the center section to alter its scale to that of the smaller starship. Among the models built from scratch were the Amorgosa solar observatory, and a saucer and miniature landscape employed for the crash landing of the Enterprise dish on the surface of Veridian III. The crash was shot high-speed in direct sunlight, then digitized and transferred into the Sabre system, where foreground tree elements, painted cloud layers and camera shake were incorporated.



Computer animation and digital mapping enabled in the *Mouth of Madness* to showcase a scene of actor Jürgen Prochnow tearing himself in half.

### *Disclosure*

*Disclosure*, Michael Crichton's novel about sexual harassment and corporate intrigue, was brought to the screen by director Barry Levinson. Set in the headquarters of a high-tech company, the production incorporated a pair of sequences involving a virtual reality device named Corridor that leads digitized characters through a Greco-Roman-style library of data files. For the virtual reality simulations – supervised by Eric Brevig – actors were photographed against a bluescreen, then digitally composited into three-dimensional computer environments. To suggest the Corridor's prototype stage of development, the bluescreened image of actor Michael Douglas was disrupted

with a noise function. Also appearing in the Corridor is a digitized image of Demi Moore – achieved by texture-mapping a wire-frame-style painting onto a transparent model.

### 1995 *In the Mouth of Madness*

Director John Carpenter relied on KNB EFX Group to create the creatures for his horror film, *In the Mouth of Madness*. However, four shots that could not be achieved with prosthetics – for a scene in which a principal character tears himself in half like a piece of paper – were turned over to ILM. The ILM team – under Bruce Nicholson – began by shooting a plate of the actor miming the tearing action. That plate was then mapped onto a computer generated model. A page from a book was scanned into the computer to create a newsprint backing. Computer animated ripping actions were timed to the actor's mimed performance.

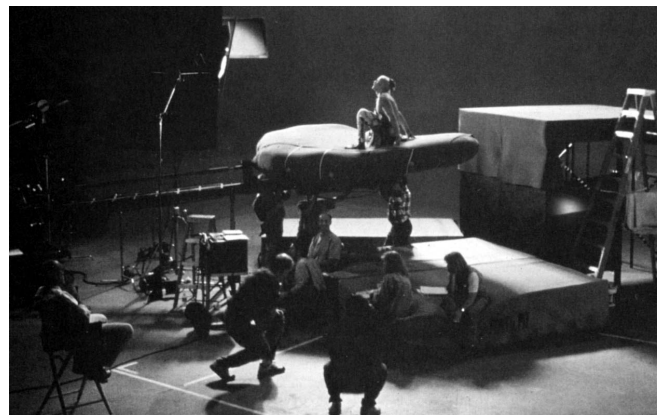
Other shots involved paintings that transform eerily. One, a scene of two lovers posed in an idyllic landscape, began as a still photograph taken on location. Using PhotoShop, Nicholson and effects art director Mark Moore animated the still images to evolve into grotesque forms. In another painting, a woman's head turns unaccountably. One photo was taken of the woman with her head turned away, and another of her looking towards camera. The in-betweens were animated using a 2-D computer animation program.

### *Casper*

For *Casper*, an Amblin production directed by Brad Silberling, digital character supervisor Dennis Muren, animation director Eric Armstrong and a crew of more than a hundred animators succeeded in transforming the simplistic, two-dimensional cartoon character of *Casper* into a fully realized, three-dimensional actor. All of the picture's ghost characters required a full range of humanlike expression and dead-on lip syncing. ILM once again expanded its CG department, hiring sixty new animators and revising internal software to make it more user-friendly for the many who had never before worked on a feature film.

An extended design phase was required before the ILM team and Amblin art department nailed down the look of the CG characters – all of which would be modeled, animated and composited into live-action plates during a nine-month-long postproduction phase. Extensive plate photography was supervised by Scott Farrar. On-the-spot animatics were useful in making the CG characters a reality on the set. In postproduction, those animatics were fleshed out, providing valuable reference for the animators when it came time to create the final ghost performances.

To facilitate lip-sync demands and the range of expression required, the ILM team created a library of facial expressions that could be reused and employed as needed. In some cases, motion capture technology was also utilized. Raw motion data collected from sensors attached to a performer's mouth was translated to a moving mouth image on the computer screen, then refined and embellished by the animators. Animation for any one shot took from two weeks to two months to complete. A total



of 360 computer generated shots were produced, with a full forty-seven minutes of screen time devoted to digital characters.

*Elaborate bluescreen setups were required for scenes of a three-inch-tall Indian interacting with a normal-size boy in *The Indian in the Cupboard*.*

### *Village of the Damned*

For John Carpenter's remake of *Village of the Damned* – about alien-possessed children in a small town – ILM produced shots of the children's glowing eyes, employing computer graphics paintbox techniques and fractal animation. A shot of an eye glow intensifying and spreading across the face of one of the child characters – revealing the alien inside – was achieved by effects art director Benton Jew, who rendered a series of images in PhotoShop that were then animated on a Domino. In a subsequent abstract montage, images representing the thoughts of the character played by Christopher Reeve were realized by combining stage elements and animated art work.

### *Congo*

*Congo* – Frank Marshall's jungle adventure – based on Michael Crichton's bestseller – featured volcanic effects overseen by Scott Farrar. Aiming to best the lava imagery it had created for *Indiana Jones and the Temple of Doom*, ILM developed a technique in which white pigment was poured over blue-painted models whose geometry corresponded to specific areas of the live-action sets. The blue color of the models allowed for easy extraction of the flowing liquid, which was then digitally colored an appropriate hot-red and composited into live-action plates. Volcanic eruptions were simulated with mountaintop models rigged to implode and spew liquid. Model photography was composited with live-action shots of a real mountain to impart an active volcanic 'cap.'

ILM also provided a brief shot of a diamond-encrusted mine ceiling – realized by photographing a ceiling model dressed with crystals – and shots of a multitude of gray gorillas advancing on a small team of scientists within a mine. For the latter scenes, ILM photographed a dozen gray gorillas – actors in suits and animatronic heads constructed by Stan Winston Studio – in various positions on the mine set, then combined the motion control passes to multiply their number.

### *The Indian in the Cupboard*

Eric Brevig served as both visual effects supervisor and second unit director for *The Indian in the Cupboard*, a film fantasy about a magical cabinet that enables a young boy to bring his toys to life – most notably, a three-inch-tall Iroquois Indian and a similarly scaled cowboy. To create the illusion of the tiny characters in scenes with full-size people and environments, director Frank Oz opted to avoid oversize props and set pieces. Instead, the production set up adjacent live-action and bluescreen units, with Oz directing the former and Brevig directing the latter.

One of the challenges faced by the bluescreen unit was the scaling up of lighting and camera moves – necessitated by the fact that the actors were actually twenty-four times larger than they would appear in the movie. Consequently, any light on the live-action set would have to be simulated on the bluescreen stage with a source that was twenty-four times more powerful in order to match the light quality and intensity. Similarly, a two-foot camera move on the live-action stage translated to a forty-eight-foot move on the bluescreen stage. Because the scaled-up action had to be executed in the same amount of time as the smaller live-action moves, Brevig's team employed a number of

crane arms and Wescam devices to propel its bulky Vistavision cameras through space in the allotted span of time. Resulting bluescreen photography was match-moved, frame by frame, to the full-size live-action. Computer generated reflections, shadows and artifacts were added to place the bluescreened characters more convincingly into the scenes.

#### *The American President*

ILM contributed only a handful of effects shots to *The American President* – a romantic comedy directed by Rob Reiner. One entailed adding a blanket of computer generated snow to a shot of a helicopter landing at Camp David in the wintertime – a scene actually photographed in summer in Southern California. Digital snowfall was created for another scene. ILM also provided background matte paintings of the White House that were composited with foreground sets.

#### *Jumanji*

For *Jumanji*, a movie about a magical board game that brings to life a variety of fantastic jungle creatures, ILM visual effects supervisors Steve Price and Ken Ralston collaborated with director Joe Johnston. Exotic plants and animals were realized either as animatronic creations built by Amalgamated Dynamics or as computer generated characters produced by ILM. Among the CG creations were a swarm of bats, a menacing lion, stampeding rhinos, elephants and zebras, a flying pelican, and a band of monkeys. Monkey facial animation was facilitated by a library of twenty faces, used in conjunction with a new software program – Caricature – that enabled animators to work with shapes, rather than individual points. The creation of realistic fur for the lion and monkeys required an investment of considerable time and effort by the CG team. Ultimately, a technique was devised in which a few individual pieces of geometry could be used to generate as many hairs as needed. Computer graphics were also utilized to turn an attic floor into undulating quicksand.

Not all of the effects were digitally produced. For a climactic scene in which a mansion and its attendant grounds were split apart by a savage earthquake, the ILM model shop created miniature replicas of the live-action mansion in two scales, prescoring and rigging them to be pulled apart manually on cue.

#### *Sabrina*

The remake of *Sabrina* – directed by Sydney Pollack – features a demonstration of an indestructible flat-panel video screen. ILM Sabre artist Chad Taylor dropped in images displayed on the screen – images not present in the live-action photography – and also created small sparks for a shot of Harrison Ford's character shooting the screen with a pellet gun. Reflections of the set – also Ford's hand on the display screen – were inserted into the live backgrounds. Ken Ralston, in one of his last duties before departing ILM, supervised the effects.

#### *In Production*



A number of spring and summer releases will feature effects by ILM. Computer generated tornadoes are showcased in *Twister*, a Jan De Bont film about storm-chasing scientists. Stefen Fangmeier supervised the project. *Dragonheart*, directed by Rob Cohen, is a period fantasy that presented ILM and supervisor Scott Squires with the challenge of creating a talking, flying, highly expressive dragon. One of the film's lead characters, Draco promises to be the most sophisticated computer generated character ever realized. Brian De Palma's *Mission*:

*Impossible* – a film adaptation of the popular TV series of the sixties – will feature large-scale miniatures and other effects supervised by John Knoll. Meanwhile, Jim Mitchell is overseeing work on Tim Burton's *Mars Attacks!*, due for fall release.

Longer-range projects include *The Lost World* – Steven Spielberg's sequel to *Jurassic Park* – *Eraser*, *Daylight*, a live-action remake of *101 Dalmatians*, and a Novamax documentary on special effects. The company has recently completed some sixty new and revised effects shots for the upcoming *Star Wars* special edition, and will be giving the same treatment to *The Empire Strikes Back* and *Return of the Jedi*. Coming full circle, ILM is also gearing up for the new *Star Wars* trilogy, currently being scripted by George Lucas.

## **ILM ACADEMY AWARDS** (BEST VISUAL EFFECTS)

1977 – *Star Wars*  
1980 – *The Empire Strikes Back*  
1981 – *Raiders of the Lost Ark*  
1982 – *E.T.: The Extra-Terrestrial*  
1983 – *Return of the Jedi*  
1984 – *Indiana Jones and the Temple of Doom*  
1985 – *Cocoon*  
1987 – *Innerspace*  
1988 – *Who Framed Roger Rabbit*  
1989 – *The Abyss*  
1991 – *Terminator 2: Judgment Day*  
1992 – *Death Becomes Her*  
1993 – *Jurassic Park*  
1994 – *Forrest Gump*

Twenty years of ILM photography by Terry Chostner, Kerry Nordquist, Roberto McGrath, Sean Casey and David Owen. Special thanks to Ellen Pasternack, Miles Perkins and Debra Amador.

# 30 Minutes with the Godfather of Digital Cinema

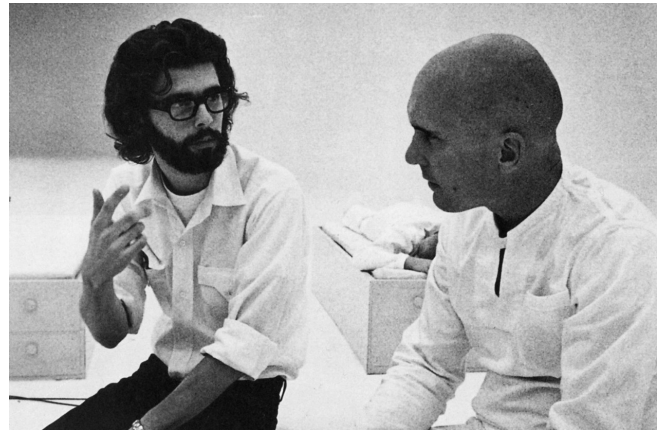
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Don Shay

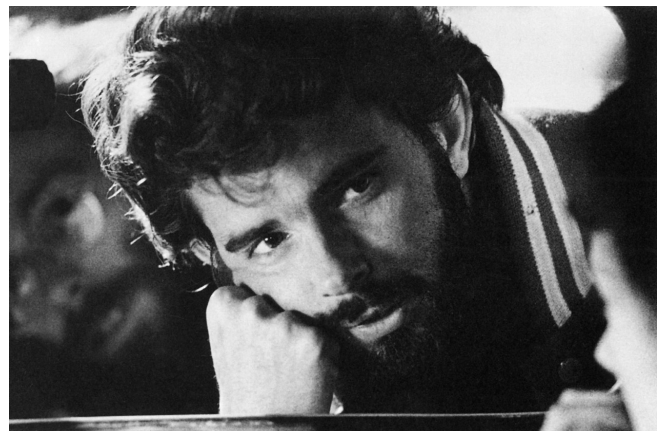
Though journalistic precepts fairly demand it, few interview subjects can be less in need of a formal introduction than George Lucas. For more than two decades, his has been a household name throughout much of the known world. Any school child can quote chapter and verse on his cinematic achievements – *American Graffiti* ... *Star Wars* ... *Indiana Jones* – but Lucas is no mere filmmaker. Possessed of an entrepreneurial spirit, he heads a trio of interlinked companies that has produced landmark advances in theatrical sound presentation, entertainment software, audio postproduction, sound and picture editing – and, of course, visual effects.

George Lucas is not a man who embraces the spotlight. He tends to maintain a low profile, and interviews with him are rare. But as plans for this, our 20th anniversary salute to Industrial Light & Magic, took form, it seemed a fitting opportunity to solicit his thoughts and reflections on the subject of visual effects and the much-celebrated company he founded to produce them. In sixteen years of publishing *Cinefex*, I had met George Lucas exactly once – a brief handshake greeting during a chance encounter at ILM many years back – but I was optimistic about the prospect, having it on reasonably good authority that he was fond of the magazine.

An ever-so-nicely worded letter was soon on its way, asking that he indulge us with an in-depth interview on Industrial Light & Magic and the vicissitudes of visual effects.



A lauded visionary whose technological contributions have advanced the art and craft of filmmaking, George Lucas was just twenty-seven when he made his directorial debut with *THX 1138*. A futuristic tale starring Robert Duvall as a renegade free-thinker trapped in an oppressive Orwellian society, the movie was a feature-length version of an award-winning student project Lucas completed while studying film at the University of Southern California.



On the set of *American Graffiti* – his second production – Lucas imparts direction to actress McKenzie Phillips. The film, a nostalgic homage to the cruising culture of the fifties, won critical raves and box office success – and secured for Lucas a reputation as a writer and director of note.

Weeks passed. Then a call from his public relations director. It was one of the good-news/bad-news variety. “George would love to meet with you.” (The good news.) “But he’s writing the new *Star Wars* movie and is only spending one day a week at the office. We have to schedule all of his appointments on that one day and we can spare you only thirty minutes with him.” (The bad news.) So much for the in-depth interview.

Aware that every one of those thirty minutes would have to count, I took exceptional pains to prepare for our meeting. I would have to narrow my focus – cut to the chase. Even with the most comfortable of interview subjects, it can often take ten or fifteen minutes to get the conversation rolling. Lucas does very few interviews. Will he warm up at all in the time we have? I pored over clipping files looking for past interviews that might afford some sense of the man and provide interesting lines of inquiry. How many questions can I figure on getting in? I want to make sure we at least touch on ILM and digital technology. Also the *Star Wars* special edition – and, of course, the long-awaited new chapters in the *Star Wars* saga. Will he be talkative or taciturn? Better figure on the latter.

For someone who has spent much of his professional life interviewing people, I was experiencing all of the first-timer’s worries and concerns.

We met in the neo-Victorian mansion that houses Lucas-film’s corporate headquarters at Skywalker Ranch – a mecca of high-technology nestled unobtrusively on a large agricultural preserve in rural Marin County. In his vast and comfortable office, Lucas settled into a sofa and opened up immediately. My first question – a little ice-breaker, just to get things started – merited a five-minute response. This is a man who dislikes giving interviews? I could see most of my questions were never going to get asked. No matter. This was not to be a formal exchange of questions and answers, but rather a genial conversation that took its own course.

Thirty minutes is not a long time, but we covered a lot of ground. All too soon we were interrupted by an assistant – whose job it no doubt was to keep her boss on schedule – with a reminder that his next appointment was waiting. Lucas protested and won us a few minutes more. Then she was back – politely persistent.

Even a Jedi master is powerless against some forces ...

You’ve long had a reputation for being a Hollywood visionary. Did you envision revolutionizing the visual effects field when you started ILM twenty years ago?

*Not at all. Everything, for me, generates from wanting to make movies. At the point when I first had the idea for Star Wars, this science fantasy thing that was going to need a lot of effects, there were really, as far as I could ascertain, no resources anywhere in the world that could do it. Maybe Doug Trumbull – who had worked with Stanley Kubrick on 2001 – but Doug was busy doing other projects and things.*

*2001 was the landmark – the biggest thing that had ever been done in the science fiction genre – and to do the effects, Stanley had put together a team from scratch, pulling people in from eclectic areas of expertise and making it happen somehow. When I went to do Star Wars, the real challenge was that I wanted to make a much more active film – which meant more shots, more cutting, more movement, more work. It had never been done before. I looked at this story I wanted to do, and said to myself: “Well, can I make this movie? How am I going to do this?” And being young, I responded: “Well, sure. I’ll figure out how to do it.” At school, I had a lot*

of experience in animation and that sort of thing, so I had a vague idea of how to approach some of this stuff from my animation background. Also, I had worked as a cameraman and an editor. I thought, "I think I know how to put this together."

No one wanted to do it at first. But after American Graffiti – which was a big hit – Fox said, "Okay, we're interested in doing this Star Wars thing." And they just took my word that I was going to be able to pull it off. That's when I had to face the reality of it.

It was a bit like my first film, THX 1138. Walter Murch and I had to present it to the studio, and we put together this presentation showing that it was going to be futuristic and outlining how we were going to be shooting it on location and such. And we put in there that we were going to develop this very unusual reality using 'rotary-cam' photography. We said: "That sounds good. Let's put that in there." Fortunately, nobody at the studio asked us what it was – because it was nothing. There was no such thing as rotary-cam photography. We thought it would make them believe that we could create this whole world with some wonderful new technique, when all we were really going to do was shoot on locations and overexpose a lot.

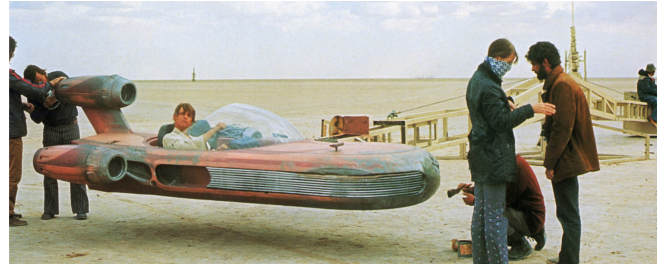
In the beginning of Star Wars, it was kind of the same thing. I was saying: "Oh, sure. I can do this. Fine. No problem." The fact was that I really didn't have a clue as to what I was going to do, other than some inclinations. I started going around – and I quickly found that there wasn't anybody to do the kinds of effects I knew I would need. The studios had no special effects departments anymore. I talked to Doug Trumbull and Jim Danforth and a few other people. Doug suggested John Dykstra, one of his cameramen.

I met with John and some others – this little cadre of people who had been doing commercials and working on films for exploratoriums and such – and I laid out the ideas I had for Star Wars, how many shots there would be and how I wanted to get a lot of movement into the effects. It was clear that we couldn't do it using any of the techniques Stanley had used on 2001. We were going to have to come up with a whole different way of thinking, because I wanted to be able to pan and have the ships move in ways that, up to that point, were not possible. Then, once we sort of came up with the process, we jammed forward in a little garage down in Van Nuys.

My purpose at that point was to get the movie made. I had no interest in really starting a special effects company or anything else. I started an art department, I started a wardrobe department, I started a prop department and I started an effects department – I had to do all this in order to make the movie and create things. The biggest issue, at the beginning, was that when I started writing the movie, I had this giant story in my head – and I knew that I could really only do the first act. When I had to stop working on the big piece and work on the little piece, I was determined that at some point, I would get the other two acts finished somehow. That's why I insisted on getting ahold of the sequel rights. I figured the studio was never going to want to do another one of these; and I wanted to be able to control it so that I could somehow sell it to somebody else and maybe get all three of them done in some way.

At that point, I wasn't even thinking that ILM would survive. I thought this group would come together, we would make the movie, and then I would go back to doing something else – TV shows or some kind of movie – to make enough to where I could get the next one made. Then I'd bring the group together again and make that. Obviously, I had no idea that Star Wars was going to be so successful – or what it would do to special effects or the industry or anything. It wasn't until the film came out that I realized that I could sustain ILM. That's when I moved it up here to Northern California and made it part of my company, and said: "This is

going to be a long-term thing. I'm going to go on and do the next movie – and then, hopefully, the third one.” Assuming that happened, I knew there'd be at least six years worth of work for ILM.



Faced with a dearth of technical resources as he prepared to film his space fantasy, *Star Wars*, Lucas recruited an army of effects artisans to help realize his epic vision. Their efforts in developing new techniques and hardware would revolutionize the visual effects field. On location in Tunisia, director and crew prepare for a scene in which Luke Skywalker – played by Mark Hamill – skims across the desert sands of Tatooine in a landspeeder.



With an eye toward camera angles, Lucas examines a cardboard art department mockup of one of the *Star Wars* sets.



In the beginning, we didn't really do a lot of outside work. It was mostly just our own thing. We were just doing Raiders and Star Wars. Later I started bringing in outside projects. Steven Spielberg was an old friend, and he'd done Raiders for me, so I let him come in first. Then we started doing more and more outside work. But it wasn't until quite a bit later that we really became an independent outside special effects company.

You were probably the first mainstream filmmaker to recognize the potential of digital technology as it applied to putting images on film. How did that come about?

Someone once referred to me as 'the grandfather of digital cinema.' I said: "Grandfather? Why not father, for Christ's sake? Grandfather's a little old, isn't it?" It must have been a misprint. Maybe it was supposed to be godfather.

Right at the beginning, on Star Wars, when John and I were going over how we were going to pull this thing off, he came up with an idea he'd been toying with of using computer controlled motion on a camera so that we could do what you can do in animation. Basically the idea was to build a kind of live-action Oxberry. Oxberrys are not run by computer, but kind of like computers – the same sort of logic. Since I'd worked on a lot of Oxberrys and understood the concept, I said: "Okay. Great." We also talked about the possibility of using some computer graphics. I knew John Whitney and some of the others involved in early computer graphics, and there were a lot of things going on at that time. So we did some experiments with wire-frame – which are actually in the movie – showing how to get into the Death Star and everything. That was very early computer graphics – the very beginning.

Out of that, it became obvious that there was a future for this technology. "This is pretty crude now, but in time ..." So I was always interested in it; and I always kept up with what John Whitney and a lot of the other people on the computer side were doing.

Hollywood is notoriously bad about funding R&D – yet you decided to do just that by establishing a Lucasfilm computer graphics division.

Yes, after Empire Strikes Back. I didn't really have the resources available to me until after that. I took all the resources I had from Star Wars and poured them into Empire. Then, once Empire was finished, I got all my money back and I was able to actually invest in other things. And the first thing I invested in was a computer division. I hired Ed Catmull to run it for me and he put a team of people together. The idea was to take a lot of the ideas we had been toying with for the last six years and put them in a more formal setting. I had a whole shopping list of things I wanted to accomplish. I could see very easily – even though I'm not that much of a computer person myself – that moviemaking was a very nineteenth-century process. Up until Star Wars, most of the special effects and the illusions we were creating on film were really illusions that existed in the nineteenth century. But it became clear that with the computer, we could begin to really advance things in a way that went way beyond what Lumiere and Georges Méliès and everyone since them had been doing. So we started pushing all of that in a lot of different directions – and out of it came everything from video games to digital editing to laser printers to full-on computer graphics.



Cast as Obi-Wan Kenobi, the sagacious mentor to young Luke, distinguished actor Alec Guinness lent his considerable stature to the now-classic film.

Was it pure research at the start, or did you have a specific objective in mind?

*I wanted to develop a digital editing system. I'm an editor, and I thought digital postproduction would really change the way we make movies – especially in the way we finish them. So I was pushing for that. I knew that once we could get an image into the computer, we could really manipulate it in extraordinary ways. I didn't know quite how – it was all very new – but I figured if we could just get that image into the computer, we could do things with it. So a lot of the focus was on that.*

*So we built a laser printer. And we built an editing system. And then we made a deal with Atari and got into games. I was very interested in interactive education. I said: "This technology is going to have a really powerful impact on the way we learn. We can make the learning process much more efficient using all these interactive tools – computers and visuals and things." So that's where the game company really came from – out of that.*

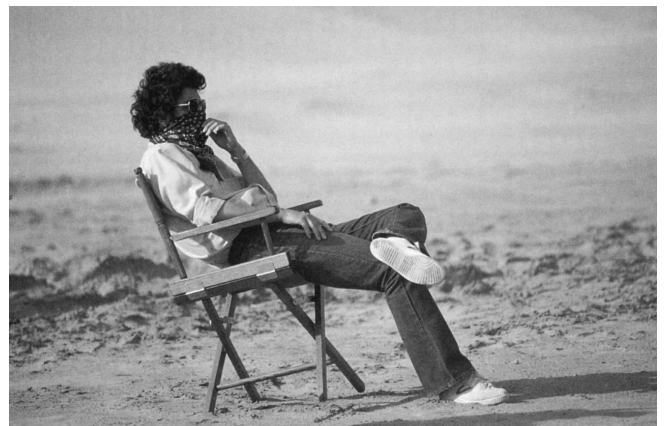
*Doing just pure computer animation wasn't on the agenda. But Ed and some of the others in the division loved computer animation – and their hearts were really there. So they were developing, at the same time, what eventually became known as Pixar – high-speed computer graphics and that sort of thing. It was a slow process then, but I figured somebody else would develop the fast computers in time. To me, a laser printer was really more important – something that we could use right away. Kodak was trying to develop one – a lot of other people, also – but they weren't being very successful at it. So the laser printer and the editing system – both picture and sound – were the primary targets I established. High-speed computer graphics was a sideline. Once my primary objectives were achieved – once we had the printer and the editing system – I sold the computer division. To me, the idea was really to use that technology to advance ILM, not to start a separate company and do other things.*

From what I understand, there was some resistance on the part of the computer division to working with ILM on practical filmmaking assignments like *Star Trek II* and *Young Sherlock Holmes*. That seems odd, if they were indeed interested in producing computer animation.

*We had a rather severe culture clash between the two divisions. ILM, at the beginning, didn't want to have too much to do with digital technology. And the computer guys didn't want to have much to do with ILM. So I started the computer division and put them in the building next door. It was like: "You can't come over here and we can't go over there." Which was okay, because the computer division had these specific projects I wanted them to create. But at the same time, they were building a high-speed graphics computer – actually building it from scratch. So the computer guys did want to do computer animation. *Star Trek II* was the start for them – but even then, what they really wanted to be doing was *Toy Story*.*

And they finally did it.

Yeah, *Toy Story* is a dream they'd had for seventeen or eighteen years – since they first started. But it was so ethereal back then. Technologically, they were far from being able to accomplish it. *Star Trek* was the first time where we sort of brokered a deal – where I got the ILM guys to say, "Let's do a piece of this with computer animation," and the computer guys to say, "Okay, we'll stop what we're doing and work on this." So there was this little project that was done



between them. Both sides were sticking their toes in the water of détente.

Everyone today is infatuated with digital dinosaurs and other 3-D creations – but from things you’ve said in the past, I take it that you don’t necessarily see that as the most influential aspect of digital filmmaking.

A lot of the technology I’m most interested in has to do with fundamental changes in the filmmaking process. With *Young Indy* and things like *Radioland Murders*, we’ve been experimenting with lots of different production techniques and different ways of using digital technology – not just in the special effects area, but all over the picture in terms of how we manage time and money and all kinds of things. My whole intent has been to make the making of a film more facile so I can better utilize my resources to tell bigger stories in quicker and more interesting ways.

You’re talking about using computer technology to build digital sets and create crowds of extras and place characters in faraway places.

Right. I got into this whole thing because I was aggravated with a lot of the tools I had to work with. To me, it was like trying to tell a story by chipping it out of stone with a hammer and a chisel. Then someone hands you a word processor. “Wow! This is great. This is much easier. I can talk faster. I can think faster. I can move things around.” So the impetus has always been that. It was like: “I shouldn’t have to sit here and chisel this stuff out this way. It’s just too hard and it takes too long.”

Filmmaking is really a process of managing resources. For a sculptor, only part of the art is the actual carving of the statue. Part of it also is knowing how to go out to the marble quarry and pick the right piece of marble – and then know that it’s big enough. If you say, “I’m going to make a seven-foot statue,” but you’ve only got a piece of marble that’s four-feet-six, you’re going to, at some point, get to the torso and realize that you don’t have any marble left. As crazy as that sounds, that’s what movies are like – only it’s harder to see, because you’re not dealing with pieces of marble. The resources you have to play with are more ethereal. But if you run out – and people do run out – it means rather dire consequences for the finished work of art.

Take *Star Wars*, for example. Part of *Star Wars* was a bold gesture by a headstrong kid, saying, “I want to tell a big story,” without actually saying, “Okay, how am I going to pull this off?” I kind of knew, in a way, but I said: “I’m going to be grand. I’m going to make it big.” And I did make it big – too big – and had to bring it down. That was very frustrating. But at the same time, you know, if you went out first and said, “Well, here are the resources,” you’d find yourself saying: “Well, my vision will only be

*Lucas relaxes in the dusty Arizona desert during location filming for Return of the Jedi. Though he has not directed a picture in twenty years – preferring the role of active producer – Lucas maintains close hands-on involvement in all of his projects.*

*To direct Raiders of the Lost Ark – his salute to the nonstop action movies of old – Lucas called upon close friend and colleague Steven Spielberg. Their collaboration would launch Lucas’ second successful film franchise – one that has produced two enormously popular sequels, with a third presently in development.*

*Lucas and Spielberg on location in Sri Lanka for Indiana Jones and the Temple of Doom.*

*Lucas turned to American Graffiti alumnus Ron Howard to direct Willow, his mythological tale of a diminutive hero’s quest to thwart the evil machinations of a sorceress queen.*

*With The Young Indiana Jones Chronicles, a television series based on the coming-of-age adventures of young Indy at the turn of the century, Lucas has experimented with a range of cost-saving digital production techniques.*

this big, because that's how many resources I have. Studios don't have special effects departments? Okay, I'll have to be very careful about my special effects. We'll have to do it like 2001 – very controlled and very linear, because that's all we can do." If you look at all the special effects films done before *Star Wars* – excluding Ray Harryhausen who was sort of an exceptional genius – for normal people, this is all you have to work with. The alternative is to do it like Ray did, and say: "I'm going to go out in my garage and I'm going to figure out a new way of doing it. And to hell with all this."

That's a young person's mind-set you're describing – yet you've been doing this for a quarter of a century. How do you keep that kind of edge?

To me, it's endlessly fascinating. One of the main impetuses in going ahead with the *Star Wars* stories at this point – aside from getting past the frustration of having four, five and six out there and not having one, two and three – is that now we've reached the point, technologically, where I can do so many things that I could never do before. Suddenly it's like having a whole new paint set – and that's fun.

And I'm going back and doing a special edition of the first *Star Wars* for the same reason. I'm having more fun doing that than almost anything – because it's like getting a second chance. I was very frustrated with the way a lot of things in the film came out. I was embarrassed by some of the things in *Star Wars* – and I was embarrassed at the time I did it. I just didn't have any way of doing it better. Being able to go back now and fix it, I can say: "Well, that was all a mistake. I didn't mean for it to be like that. That's the way it came out in one take. With one more take, I can really make it great."

We have a new Jabba the Hutt that's so much better than the old one I had to work with. I mean, that one wouldn't act! It was just a big old rubber thing. But now I've got one that's very articulate. Its speech is fantastic – the lip-sync is great. The tongue is great, the eye movement – everything! And he walks, too. So it's like this great thing. Suddenly all the constraints are lifted. It's like you've been plowing fields in hundred-degree sun, with a seventy-pound backpack and lead balls chained to your ankles, and someone comes along and puts you in an air-conditioned tractor, and says, "Look, it goes real fast and you can do everything with it." And you say: "This is great! This is fun!" You want to plow fields all day long, it's so much fun. That's basically what's going on now. We're doing the new films, and it's like: "Gosh, I can have Yoda walk. I could never have Yoda walk before. And, you know, I don't have to stage scenes around R2 and 3PO anymore. I can actually make them more facile. And other characters – I can create characters that don't have to be people in suits." That's where the real thrill of it all comes. That's what's bringing me back to doing it, in a way – just the fun of it.

On your special edition, do you expect any backlash from fans who might resent your tampering with a classic?

I don't know. It's my classic. On the one hand I'm doing this, while on the other I'm on the Artists Rights Board, a foundation that's trying to protect films from being changed – which I feel very strongly about, because with the technology we have today, anybody can go back and do this kind of thing. I can sort of see the future, and I want to protect films as they are and as they should be. I don't want to see them colorized, I don't want to see their formats changed, I don't want to see

them reedited, and I don't want to see what I'm able to do now, which is add more characters and do all kinds of things that nobody even contemplated before.

What I'm doing, I think, is what a lot of painters do, and some writers do – which is to go back and repaint or rewrite. Go into any artist's studio and you'll find lots of paintings on the wall that look completely finished and completely fine. And the artist will say, "Well, I'm leaving them there because I'm not happy with them." If I had been an artist and a painter, and I had done *Star Wars*, I would have probably left it on the wall, because I wasn't happy with it, even at the time. Everybody else was saying: "This is great! Didn't it turn out great?" And I would say: "No. I had to compromise. It didn't turn out the way I wanted. It fell short of what I wanted it to be." And they would say: "What are you talking about? You must be nuts!"

Well, now they're going to find out what I was talking about. Finally they're going to see what it was that bugged me so much – because now I can have it be exactly the way I wanted it to be. Well, maybe not a hundred percent. But it went from being what, in my mind, was maybe sixty or seventy percent of what I wanted, up to now being about ninety-three or ninety-four percent of what I wanted it to be.

In another ten years, you can go back and get that last six percent.

Yeah, I can redo the whole thing all over again. But truly, there's something very satisfying about having a thing not be right and always wanting to fix it, and then finally getting the chance to do it.

Now that you've done this with *Star Wars*, are you going to be able to resist the temptation to fix the other two?

I am fixing the other two. I'm doing all three of them.

One of the things you've addressed on the new *Star Wars* series is getting costs under control – trying to break the cycle of the \$100 million event picture. You've indicated you think you can do these films for sixty or seventy million.

In making movies, one of the most important parts of the creative process is managing the resources – because you're going to have limited resources and you're going to have to do the best with what you have. It's erroneous to think that you have unlimited resources in whatever you do. Some people think that, and they end up with \$200 million movies. Well, if you have too many \$200 million movies, you're going to run the studios out of business and nobody is going to make movies anymore. So you have to understand, it's like conservation of the land. I come from a farm background. If you don't rotate your crops and take care of your land and protect it and respect it, pretty soon it will go fallow on you, and you won't have any crops – and you'll starve to death. Just understanding that in the film business is a lot of what I'm trying to do on *Star Wars*. With digital technology, I can get the cost down and thus make the films more epic, grander in scale, and tell much more sweeping stories – which I plan to do.

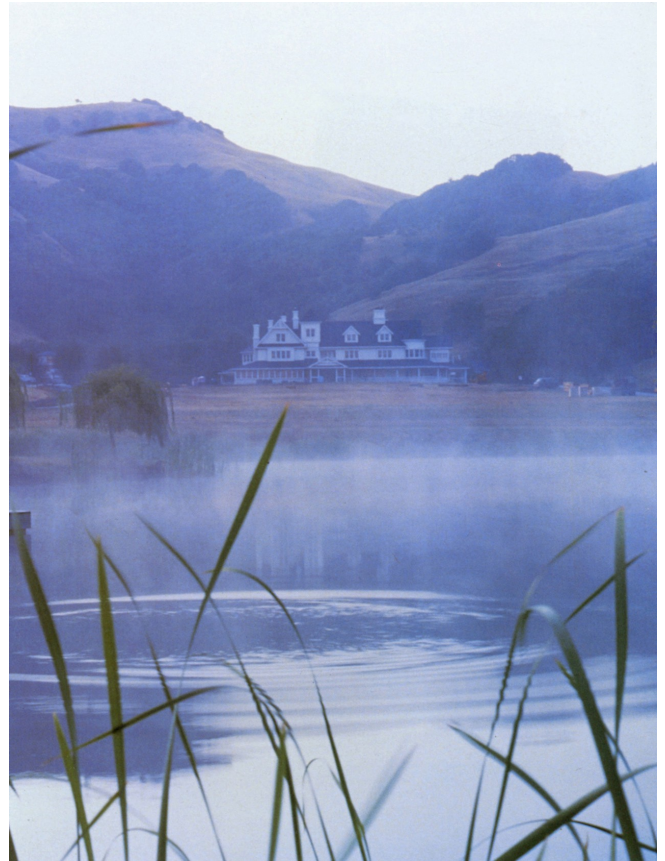


You were certainly at the forefront of the digital revolution – and until recently, ILM was years ahead of the pack in terms of capability. You had a decade's head start on everyone else in the business. But some heavy-hitting competitors are now in the game. Where do you feel you stand right now?

I think we're still easily three years ahead of the pack – probably five in most cases. Most of our competitors are being funded by deep pockets, but their ability to do the things that we do, I believe, isn't there yet – no matter what they say. It's one thing to do spaceships, and it's another to do people and animals and hair and skin. There's a huge leap there. Most people don't realize how big that gap really is.

Ultimately, the whole point to ILM is that it's there to do good work. It has to be fiscally responsible so it can continue to do good work; but I started it, really, to be a service to me, so that when I want to do movies, I can have the best possible group of people working on them, and the best technology and software and everything else to create what I want to create. It's not there as part of a larger corporation expecting it to make profits. ILM is not really about making money. It takes all the money it makes and pours it back into research and development and buying more capital expenditures, more equipment, so that the people there have more to work with.

We spend a lot of time and money training people – and most of them stick with us. But some move on and start their own companies. Much of this business has been created by ILM – and most of the people in the business that run the companies have been educated at ILM. We figure that's part of our agenda, to train people and create a sort of atmosphere that is dedicated to people who want to have a creative lifestyle. As a result, I think we're able to maintain a lot more quality than most companies. The people who work here are much more focused and dedicated to the creative part of it. I'm proud of all the people who are here now. And I'm proud of all the people who have gone through here and started other parts of the business. I'm not really worried at all about the competition. I don't think there will ever be competition – because what we have is a lifestyle and a mind-set. We're not trying to be bigger than everybody else. We just want to do really good work.



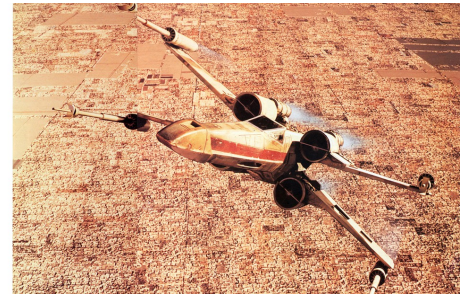
*Skywalker Ranch was conceived by George Lucas as a creative mecca, free from the distractions of urban existence, for his various entertainment and educational enterprises. Nestled in a 4700-acre agricultural preserve north of San Francisco, its Victorian-style main house is corporate headquarters for the Lucas triumvirate – Lucasfilm, Ltd., created more than twenty years ago to oversee feature and television production; LucasArts Entertainment Company, a leading international developer and publisher of entertainment software; and Lucas Digital, Ltd., specializing in visual effects and audio postproduction. The complex also houses a major archival collection and research library.*

# WAR STORIES

article by  
Kevin H. Martin

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In 1971, Warner Brothers released a low-budget, yet high-minded film called *THX 1138*. The futuristic chiller – an expansion of an award-winning student film by its writer-director, George Lucas – garnered mixed reviews and lackluster grosses. Disappointed by the lack of response to his ‘serious’ science fiction effort, the young filmmaker readjusted his sights and began work on what was to become *Star Wars*. Pitching the story as an updated *Flash Gordon*, he gained studio interest – but no commitment; so Lucas set his space opera aside, moving on to co-write and direct *American Graffiti*, a smash hit whose success increased the viability of *The Star Wars*, as it was then titled. But despite Lucas’ newfound clout, the science fiction genre was, at that time, considered so risky that he was still only able to get a deal memo for the film from Twentieth Century fox.

To serve as visual reference material, Lucas purchased several pieces of space artwork from artist John Berkey, then began drafting his fantasy in earnest. One of Berkey’s illustrations – a rocket-plane diving down from space towards a gigantic metal world – seems to have especially caught and held the director’s eye. It would, in fact, be echoed in his film’s climax as squadrons of Rebel X-wing fighters attack the Imperial Death Star. The remainder of his script reworked old movie themes and fairy tales, incorporating essential precepts of Joseph Campbell’s essays on myths and their power. The result was a story, both old and new, of young Luke Skywalker embarking on the hero’s journey to rescue a princess and vanquish an evil fortress,



With his 1977 production of *Star Wars*, writer-director George Lucas launched a renaissance in visual effects. In the film – a story of an intergalactic struggle between forces of good and evil – Lord Darth Vader and Jedi master Obi-Wan Kenobi engage in a lightsaber duel aboard an Imperial battle station. In staging the fight, the actors used prop swords covered with highly reflective front projection material onto which light was shone. The consequent glow was later intensified through rotoscoping.



The film also featured scenes of combatant spacecraft engaged in highly kinetic dogfighting. Contemptuous of locked-off cameras, Lucas sought to capture the aerobatic warfare in fast-moving documentary-style fashion. To realize that vision, a young crew of effects artisans was assembled – led by special photographic effects supervisor

along the way discovering his true nature and the power of the mystical 'Force.'

*John Dykstra – and a facility instituted under the name Industrial Light & Magic. Among the innovations engineered during the production was the Dykstraflex, a track-mounted motion control system capable of producing repeatable, multiaxial camera and model moves.*

While developing the epic project, Lucas became acquainted with NASA illustrator Ralph McQuarrie, engaging him to produce full-color renderings of five key scenes. Lucas used these striking illustrations to accompany and augment his script – a masterstroke of packaging that would ultimately help sell Fox on doing the picture. McQuarrie remained active throughout the production, creating an additional seventeen preproduction paintings before segueing into set and spaceship sketches, then finally joining the matte department to contribute several paintings to the finished film. Lucas next hired Colin Cantwell – a member of the so-called 'class of 2001' – to build study models of the principal spaceships.

To oversee the film's visual effects, Lucas approached Douglas Trumbull – one of the effects supervisors on 2001, who had subsequently directed *Silent Running* and established his own effects company, Future General Corporation. Though Trumbull turned him down, Lucas found a viable candidate in John Dykstra – a young cameraman in Trumbull's employ – who had worked on production and effects for *Silent Running*, then left to develop a computer-controlled camera for an academic project. "I was back working for Doug at Future General when I got a call from producer Gary Kurtz about *Star Wars*," Dykstra recalled. "They sent me a script and I met with Kurtz, George and some others to discuss the sorts of dynamics they wanted to see. George spoke a lot about World War II air battles, with the key issue being a moving camera. He wanted a sense of reality through participation in the dogfight, rather than standing to one side and just watching it. He asked if I could create a system that would allow him to get these kinds of images on film. Any seasoned professional would probably have told him he was out of his mind. I didn't."

Achieving effects shots with moving cameras would require a commitment to technology and the development of motion control. "Doug – and others before him – had utilized forms of motion control," stated Dykstra, "but the moves were limited, as was the quantity of shots that could be done on a daily basis. With some work, I thought the process could be turned into a manufacturing operation able to cope with large numbers of multi-element shots. That, plus the incorporation of motion blur, was the technological key to the whole project."

How the elements would be assembled was another issue. Back in the sixties – during a four-year stint doing commercials and effects at The Westheimer Company – Richard Edlund had devoted some time to experimenting with bluescreen. "We were testing its applications for black-and-white commercial photography using high-contrast film," Edlund recalled. "We put this lace thing over a girl's head and hit it with a fan, then saw whether we could extract the image successfully." Years later, while working at Robert Abel & Associates, Edlund found himself spending long hours crunching numbers manually, inputting move data for their version of motion control through a teletype machine. One hundred different camera passes for a three-second cut was not uncommon. "There were times when I would move from one camera to the next in the middle of the shot, then switch the film into a bipack. We did this because we were going from camera negative to tape for the commercial, and any image loss from duplication would have reduced the quality enormously. I

started looking for a way to get higher image quality in the original so that we'd be able to go a generation down the line and still produce excellent images."

Edlund uncovered a Vistavision printer – last used on Cecil B. DeMille's *The Ten Commandments* – and realized the larger image size afforded by the eight-perf format would be ideally suited for optical manipulation. Vistavision was one of the widescreen formats devised to combat television's encroachment on film audiences of the fifties; but aside from its continued employment by the Disney matte department for plate photography, it fell into disuse for a decade or more until Edlund joined the *Star Wars* effects team as first cameraman and resurrected it. Signing on with Edlund was mechanical designer Richard Alexander. "At Abel's," Edlund recalled, "there was very limited technology available to build special rigs. All Dick Alexander had was a drill press, with a dovetail you could put on top to turn it into a funky milling machine. When *Star Wars* came along, it afforded Dick an opportunity to build the kind of shop he needed; and it gave me the chance to build a visual effects system the way I thought it should be built, allowing me to serve on the movie as its photographic architect, if you will." For a time, Dykstra and Edlund debated the use of Trumbullstyle double-pass matting versus bluescreen. "Since the visual concept required these ships to be whizzing by," Dykstra explained, "double-pass would not have given the trailing edge of the matte the same consistency. In the end, it turned out that motion blur became our friend – it hid a multitude of image and compositing defects."

Both men concurred on the use of Vistavision; and the printer and several ancient cameras were soon acquired cheaply. "Technicolor was selling off their old stuff by the pallet," marveled Edlund. Among the equipment items purchased was a bulky Technirama camera, which, after being modified to take Mitchell magazines and outfitted with a motorized head, was used to shoot starfields and other background elements on its fourteen-foot track. Edlund also rented a modified Cinerama camera from Linwood Dunn, who had converted it over to Vistavision. A Vistavision HS-2 rounded out the shop's production cameras, all of which Edlund equipped with ball-jointed lens mounts to allow for follow-focus applications.

To complete shots utilizing these components, an optical compositing department had to be assembled. "Robbie Blalack was out of CalArts and had an innate talent for understanding photographic processes," Edlund recalled. "The only problem with setting him up as our optical supervisor was that he had never worked with bluescreen before. So I called an old Westheimer associate, Billy Reinhold, and asked him to come in and teach Robbie bluescreen. Bill had worked with large-format films and done opticals on everything from *King Kong* to *It's a Mad, Mad World*. He served as the whole optical department's mentor – sort of their Obi-Wan. Wadsworth Kuhl at Technicolor gave us some input, too, as well as Pete Vlahos, who had come up with that intellectually perfect blue/green color-difference matting system."

From his military service, Edlund was familiar with RAR – rapid access and recovery – which allowed black-and-white film tests to be processed in about fifteen minutes for immediate review. "The ship, or whatever else we were shooting, would show up in negative against a clear field," explained Edlund. "I had Don Trumbull modify a Moviola with a cannibalized Vistavision movement – and that turned out to be a really crucial piece of equipment because we could stack seven or eight pieces of film and look at them all in 'multipack' against each other. Since each ship was shot separately, for the most part, we could thus tell how each element fit with the others in the shot,



and whether one needed to be speeded up or slowed down or repositioned in the frame.” Edlund was also insistent that the facility’s optical printer be upgraded for maximum image quality. “Don discovered a man named David Grafton, who’d been working as chief lens designer for Xerox. Field lenses are the Achilles’ heel of any photographic matting process; and David was able to develop one for us so we didn’t have to deal with a piece of glass that would chromatically destroy whatever was on the imaging lenses.”

While the appropriate equipment was being purchased and modified, a Van Nuys warehouse was leased to house the effects company. The exact requirements for the facility were at first unclear, though Dykstra had a template to follow. “Doug Trumbull’s place was essentially a one-hundred-by-fifty-foot clear span, with room to both build and shoot models, as well as engineer the necessary rigs. We knew we’d need a similarly sized space that we could then reconfigure for multiple uses as the need for additional departments arose. Back then, if you wanted a room, you put up a couple of two-by-fours and a sheet of plywood. Counting the mezzanine, the building we had was about 15,000 square feet. It was the antithesis of a studio environment, where you’d have dedicated areas for each department. Whenever we finished with a phase of the operation, that area would immediately be available for something else.” Industrial Light & Magic, as the company had been christened, moved into its unfurnished home in July 1975. Over the next twenty-odd months, Dykstra – aided by Richard Edlund, acting associate producer Jim Nelson and production manager Bob Shepherd – would assemble a youthful staff of dozens, drawn from art schools, effects houses, and a variety of seemingly unrelated fields.

George Lucas was still refashioning his screenplay, hoping that Fox would finally give the picture a full green light. But from July until December 1975, ILM would be financed entirely out of his own pocket. The windfall from *American Graffiti*’s success had made this possible – but Lucas would not be able to continue funding the facility indefinitely.

In the early months, it was up to John Dykstra to create the technical infrastructure required to produce the kinds of images Lucas envisioned for his film. “There was the visual side and the technical/mechanical side,” said Dykstra. “Except for Richard Edlund and Dick Alexander, the people assembled to build the equipment for *Star Wars* were guys who were not principally film industry veterans. Our initial technical thrust was to solve the problem of making the camera fluid. My experience with Doug was working out of warehouses, not studios, where we built what we needed. In hiring the people for *Star Wars*, I was biased strongly toward their understanding of the mechanics required to create images. Their past film credits or cinematic knowledge were much less of an issue to me.”

Compatibility was an issue. “As a group, we had a strong artistic sense that was unified in vision – a necessity when you consider the size of the facility and all of the work that had to be accomplished. There weren’t reams of planning sheets and blueprints. Electronics systems designed and built for our applications were wire-wrapped, handmade boards rather than boards etched from detailed schematics. The only reason we could work in this manner was because we understood one another. It was a kind of telepathy that served as shorthand.”

This off-the-cuff camaraderie approach was less than reassuring to the Fox executives who would soon be footing the bill for the facility. “There was nothing on paper,” Dykstra declared. “Today when



you start a business, you make a statement of purpose, list the departments and staffing needs, and develop operating budgets. What I did was just start at one end of the plate of spaghetti and start eating. In retrospect, it would be easy to say I had a plan – but I didn't have a real plan. I knew what we had to achieve and when it had to be done – and, in most instances, I had a 'B' plan in case something refused to work – but for much of the work, we moved so fast that by the time we codified anything, it was already obsolete. Fox couldn't follow what we were doing, so they pestered Jim Nelson, whom George had brought on to oversee our operation. Jim acted as a buffer between the studio and us – but it was difficult for us to give him what he needed to keep the studio at bay. When studio execs came out, we didn't want to hear about it – which was an unfortunate attitude to take. I've since learned to pay lip service. What we should have done was shoot some film – any film – so they'd feel like they had some product coming out. But we didn't do that, and there was no diplomacy involved. Coming from industrial design, my belief was that people who don't understand what you're doing will leave you alone to do your work. That wasn't the case here. There was some posturing on my part along the lines of: 'I can't be bothered explaining this to you now – just don't worry.' I think most people realize that you don't take these kinds of angry, provocative positions unless you're a little nervous about what you're doing; so that attitude wasn't exactly reassuring.

“On top of that, a lot of us gave off that 'long-hair-and-Levi's' attitude. We wore shorts and flops to work; I went to meetings at Fox wearing an old T-shirt. It was a combination of the times and our personalities. With Doug, it had always been a very relaxed atmosphere, without any of the boardroom stuff. So when this outside studio interference started affecting what we were doing, I turned a blind eye to it and acted as obnoxious as possible – just to keep things going. We knew that corporate guys with short hair who showed up were going to give us shit, so we never gave them a chance to start up on us. Jim Nelson worked very hard to bridge the gap.”

The development of the motion control system that was so crucial to the project was aided considerably by Alvah Miller and Jerry Jeffress – electronic designers who would contribute heavily to *Star Wars*, as well as the year's other big science fiction blockbuster, *Close Encounters of the Third Kind*. “They were sidekicks,” Edlund commented, “and there was a bit of technological crossover between the two films since Jerry was on *Close Encounters* while we set up ILM. Production manager Bob Shepherd was extremely useful in aiding our lookout for weird parts – solid-state memory chips, digital clocks and other stuff that was high-tech for its time and really made *Star Wars* possible. Our driver, Mark Kline, also came in handy because he understood what we meant when we wanted linear activators and really high-quality aerospace parts that could be rustled out of bins.”

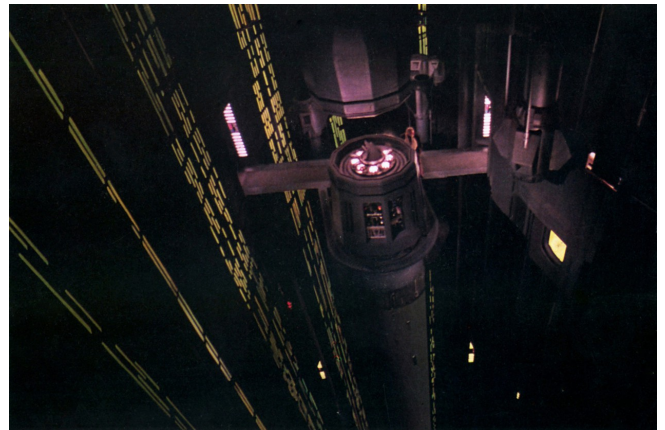
The motion control tracking camera was created virtually on the fly. “We’d all sit down to talk about what a given circuit would have to do,” Dykstra recalled, “and Al Miller would be there wire-wrapping the boards, making changes to take these requirements into account. Many, many modifications were made to the motion control system as we progressed. George would develop the shot ideas further and get new ideas while shooting the live-action, and that would impact on what we needed to shoot and how we would go about shooting it. For instance, when the camera wouldn’t go as fast as we hoped, we slowed the frame rate down.” For the Dykstraflex – as the system was dubbed – the true measure of success lay in its operation record during the show. “We shot for ten months using a prototype motion control camera and had less than a week of total down-time. That’s miraculous!”

Edlund worked with Don Trumbull to design a Trojan head for the Dykstraflex that would enable the camera to be suspended. “With the camera hanging in this little basket,” said Edlund, “we were able to do tilts and rolls and get in very close to the ships – a necessity with the small size of most models.” Dennis Muren, who was hired later as second cameraman, recalled that early ideas for the Dykstraflex were less elaborate in concept. “At one point, the camera was going to be on a fixed pedestal, able to pan, tilt and roll while the models did the same. But the system’s flexibility grew enormously when they realized that they could put this thing on a boom arm. Initially, we thought that the model pylons would be stationary; but we ended up putting them on a track as well, so the ships could go left and right while turning and tilting on the rotators.”

Committing to motion control photography in a ‘manufacturing’ mode meant that a model would be attached to its pylon mount at one of six points. A number of shots would then be recorded before the model was remounted or another took its place. There were no held takes. The memory system had to repeat precisely, because it could be weeks before other elements were filmed, and months before the elements were all composited. “We couldn’t composite in-camera because we were always going to have to go on to the next shot or setup,” Dykstra explained. “It was the only way to finish the work in the time we had. It required an enormous leap of faith – on everybody’s



*Matte artist Harrison Ellenshaw moonlighted from his position as head of the Disney matte department to render a number of paintings for Star Wars. A custom-built apparatus enabled the artist to paint on the same stand he would later use to photograph the matte shots.*



*Throughout the film, matte paintings served to extend the scope of sets built by production designer John Barry. For a down-angle view of Ben Kenobi deactivating a tractor beam within a Death Star service trench, live-action set photography was composited with a painting rendered by Ellenshaw.*

part. We were told that we couldn't do bluescreen that way – but Robbie Blalack tried like hell and got those shots through optical with whatever was needed, be it low-contrast mattes or multiple mattes. We were not so steeped in film tradition that we wouldn't try something outrageous. Some of our mistakes ultimately led to workable solutions.”

New standards included DC light sources for backlit blue-screens and blue pylons to support the models. Direct current provided a flicker-free blue, and through careful distancing of the models from the screen, blue spill – while not entirely eliminated – was greatly reduced. The blue-wrapped, internally neon-lit pylons minimized rotoscope work, though great care had to be taken on the stage to avoid casting a matte-chewing blue glow on the miniatures.



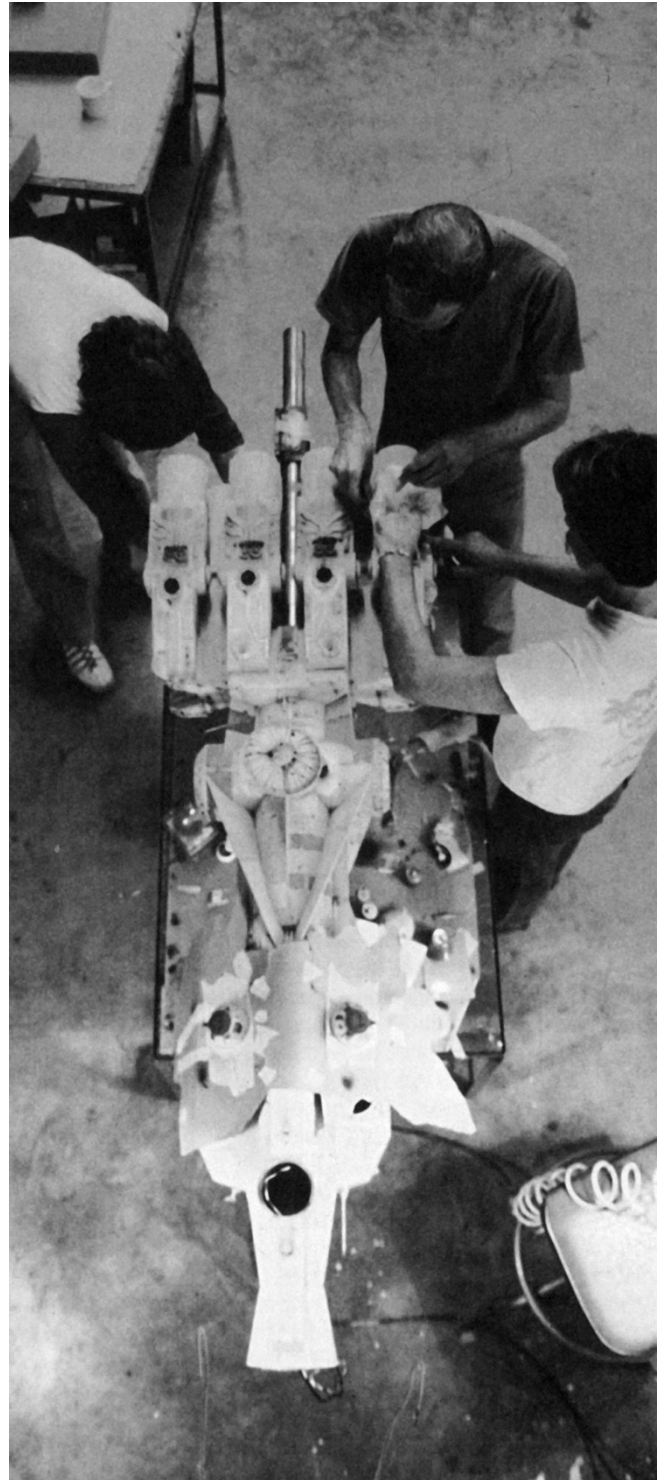
*Among the approximate seventy-five models constructed for the film was the Rebel Blockade Runner, seen only briefly in the opening sequence as it passes close over camera attempting to elude an Imperial Star Destroyer. Special components designer Jamie Shourt and chief modelmaker Grant McCune assemble the acrylic understructure of the model.*



*The pair near completion on the basic form. Final detailing and painting of the six-foot craft were delegated to others on the team.*

While hardware was being built or modified for the production, additional crew members were recruited. Among the initial fifteen people hired for the facility was Steve Gawley – on break from industrial design school – whose lengthy stint as a modelmaker on *Star Wars* was preceded by time spent in the art department. “I did pattern drawings of the spaceships to be used by the model shop,” noted Gawley. “Joe Johnston, the effects art director – an old classmate who drove to work with me each day – had redesigned the ships from the original Cantwell models and continued to have input on my drawings right up until the moment they went over for fabrication.” After three months at the drafting table, Gawley persuaded chief model-maker Grant McCune to let him join the model crew. The first thing he did was detail the escape pod model – fashioned from a paint bucket – whose ejection from the Rebel Blockade Runner was accomplished practically. Because the motion control and compositing systems were not yet functional, it was one of the few shots that could be completed early in the production. The pod – together with a scaled-up section of the Blockade Runner – was mounted on the tines of a forklift, with a camera angled down on it, then elevated above the stage and dropped onto black duvetyn.

While Gawley was still drafting spaceships, Joe Johnston – struggling under the weight of storyboard requirements – was assisted by Paul Huston, who had studied under Jamie Shourt in college and worked as a filmstrip illustrator in Colorado. “Jamie was in charge of special components on *Star Wars*,” said Huston, “and he told me about this project before he came out here to work on it. So I dropped by to say hello about the time everything was ramping up. Bob Shepherd started talking to me about my filmstrip art; and before I knew it, they had me drawing storyboards. We were still using the study models as a basis for the boards; but Joe told me to not let myself be limited by what I saw, and encouraged me to improve things that looked rough.”



*Because the model was originally intended to serve as the Millennium Falcon – an idea nixed by Lucas due to its finished-state resemblance to a ship in the Space: 1999 television series – the Blockade Runner was built in relatively large scale and detailed with meticulous care.*

With storyboards, even at best, only key positions and directions of flight could be rendered on a single panel. To further visualize the spacecraft dogfight sequences, Lucas assembled a film comprised of World War I and II aerial footage. “George’s dogfight film really helped out,” Huston stated. “It was a true predecessor to the animatics everyone now uses, and it augmented the boards in a way that really helped the motion control cameraman understand the true dynamics and point of the shot. This was of great importance because we only had forty-two feet of track, and that limited what we could do spatially. The camera had to register the story point in a very brief and economical way.”

Richard Edlund observed a key relationship between the velocities of certain aircraft on the film and the spaceships he would be shooting. “A dogfight between a Spad and a Fokker is much more interesting to watch than one between an F-18 and a MiG – the speeds at which jet aircraft fly now just don’t allow for intricate maneuvers. The *World War I* footage we observed included steep banks and aerodynamic turns – which were possible with biplanes because their additional wing surface provided greater maneuverability – and that looked a lot more dynamic and interesting to George and to us. So we kept those kinds of turns while maintaining speed levels just under those of the World War II fighters. It may not have been scientifically accurate, but we were making George’s movie, not something for six guys at the Jet Propulsion Laboratory.”

Huston segued from storyboarding duties to model building when the production discovered that there was a shortage of industry craftsmen available to create feature quality miniatures. “It got so desperate that they actually ran an ad in the L.A. Times for modelmakers,” Huston recalled. “While I lacked any specialized modeling skills, my general architecture background was enough to get me started.” Huston worked extensively on the *Blockade Runner*, as did Dave Jones, who detailed the cockpit with a microscopic *Star Wars* poster and a sexy centerfold. Ironically, the intricately-crafted six-foot miniature was to receive less screen time than any other major ship in the film. Originally, it was to have served as Han Solo’s Millennium Falcon; but upon viewing the finished spacecraft, Lucas turned thumbs-down on it, citing a similarity to the Eagle vessel from the television series *Space: 1999*.

Grant McCune with Bill and Jamie Shourt, fashioned the essential model shapes – each armatured for multiple mounting points – then engineered their internal lighting and wiring before passing the miniatures on to others for detailing. Detailing consisted primarily of kit-bashing models, panel scribing and airbrushed weathering. “We bought many model kits,” Steve Gawley recalled, “including ones returned to the store because they were incomplete. We were just using pieces, so incomplete kits didn’t matter to us. We could save money by buying them at cost. We also got a lot of things from a surplus warehouse across the street.” Possessed with the industrial design mindset common to many of the team members, Gawley strove for reality in his panel scribing of the X-wing fighters. “Joe Johnston art-directed the models as they were being constructed, then gave them those wonderful ‘used’ paint jobs we are now familiar with. It was a priority to finish the X-wing because it also had to be constructed full-size. When we finished, it was sent to England to serve as a reference for the main unit set builders. For the Falcon – which went through a major redesign and didn’t get finished until much later on – we just sent drawings and a lot of still photographs.”

Also joining the ILM crew was Douglas Smith, whose brother Wayne had worked alongside many of those who had cut their teeth on *Silent Running*. “I was trying to go to college on no money,” Smith



related, “working at a pizza parlor. So my brother – with whom I was staying at the time – suggested I talk to these guys doing a science fiction movie in a warehouse. They put me to work as a gofer. I had an interest in photography, so I volunteered to help out on stage. Later, the story started that I got on at ILM by delivering a pizza there while they were short-handed. For the record – totally untrue.”

Smith worked on stage with Richard Edlund. “At first I was afraid to load the camera by myself for fear of screwing it up and wrecking the shot,” Smith admitted, “but eventually I became Richard’s extra pair of hands, and got a terrific education in this whole new way of shooting. We tried many different ways to input move data to drive the stepper motors. At one point, we even had war surplus fighter plane joysticks. We tried doing pans, tilts and rolls using these in tandem, programming the whole move on the fly. Later, we tried various combinations of wheels and pots before eventually settling on a single bar with potentiometer knobs on it. The gear ratios were maybe not as good as they could have been; but it’s really only now that electronics can drive stepper motors fast enough to operate in real time. Back then, we were extremely speed-limited, operating at perhaps a tenth of real time.”

Just ending a move on the Dykstraflex required a soft touch. “You had to very slowly move to the zero input position on the knob,” explained Edlund. “If you didn’t do it just right, you’d have to build the move from scratch all over again. There was no way to manipulate the move data after the fact. Moves were all done by hand, one motor at a time, generally starting with the gross track move and building toward the finer motions. We were able to save a lot of time by putting two or three ships on pylons and shooting them in groups.” Elaborate stage rigging often involved as many as thirty C-stands, holding flags, diffusion and custom lighting effects. “We got so close to the models that we scraped paint off with the lens on more than one occasion. We used matte boxes made out of tape and cards so we could customize their shapes to accommodate close flybys of both models and stage lights. I’d actually have flags for the lights set up on motion control push-rods so I could change their attitude as the camera slowly went through its move. Occasionally, the camera would crash into the model – and the model shop guys would have to come out and do Red Cross fixes before we could go on.”

As elements began grinding out, miniatures were snatched from the model shop for use on stage – often before they were finished to their makers’ satisfaction. “That was something we had to learn to live with,” Paul Huston noted. “Producers want just the bare minimum of needed detail on miniatures, whereas the artist in each of us strives to create museum-quality work. We didn’t always have the time to really finish our models – at least not to the degree we would have liked – but you can appreciate how good they were when you realize they’re still in shape and filmable two decades later. Our miniatures actually wound up in an art show – the Lucasfilm Archives Exhibit – so they turned out to be museum pieces, after all.”

Although individual and departmental strivings for perfection had to place second to completing the project, it rarely meant sacrificing much in the way of quality. “We were tackling problems, solving them, and trying to hit some milestones along the way,” Dykstra stated. “It was like deciding to go to the moon – ‘projections indicate that the technology exists’ – but then you find that you have to get there within two years, and that complicates things enormously. You can still accomplish the mission, but it’s going to take a lot of money and there won’t be time for anyone to

make mistakes. Frankly, it's a miracle all the various processes and departments came together in the time that they did. If our motion control hadn't worked, we'd have been dead; if the eight-perf printing techniques hadn't worked, we'd have been dead. And no one from the outside really knew what we were doing, because we were creating this stuff from scratch."

It was almost Christmas, and ILM had yet to produce any film. Concerned, Fox sent veteran effects gurus Linwood Dunn and Cecil Love out to evaluate the facility and its personnel. "Lin was really sharp," said Richard Edlund. "He just took it all in and let me know that scheduling was going to be the key – and he was right. Cecil Love was probably about eighty-five, and he had a real deadpan face. Watching him while John Dykstra held forth in an evangelical fashion about our technological advances was incredibly funny. John was about a foot taller than Cecil, gesticulating and looking down as he spoke of motion control and motion blur – while Cecil just stared up at him the whole time with no expression or reaction at all. John got even more dynamic and animated – but Cecil's expression still never changed. I don't recall his giving us any advice."

For the Rebel assault on the Death Star, it was determined that large-scale miniatures would be required for surface background plates. Faced with a huge construction project, Dykstra brought in additional personnel to fabricate foam modules that could be cast for easy replication and assembled in a variety of configurations. Connecting pipes and detailing would then be applied to bridge the individual units and unify the overall structure.

Given a two-week contract to produce the prototype modules was a small industrial design firm run by Lorne Peterson and Jon Erland. Although silicone molds and injection molding techniques were common in the industrial world, they had not often been employed in the film industry. Peterson and Erland introduced the ILM team to these processes. "As a result," said Peterson, "we became very useful to the production. Our two weeks turned into two months – then the better part of two years. We suggested they buy a small injection-molding machine – which they did – and that was used to produce a fair number of pieces. But kit-bashing was the predominant detailing technique used throughout the show."

Detailing of the Death Star surface was the first assignment for Peterson and Erland. "The production was swamped," stated Peterson, "and nobody wanted to spend their time detailing acres of Death Star pieces. We detailed these two-foot-square foam panels, then farmed them out to another company that did plaques and the like to get multiple urethane castings." After the modules were assembled in the parking lot – a configuration covering more than 1600 square feet – the next step was applying thousands of pieces of Scotchlite for windows. "That was extremely labor intensive. We'd have four guys crawling around on foam kneepads with X-acto knives and a pair of scissors, applying this 3M tape. Eventually, one or more of us would be called away to help elsewhere – and since we all hated putting the windows in, we'd stay wherever we'd been summoned for as long as we could. Grant would come outside and find that nobody was working on the Death Star; so he'd go through the building ordering everybody back onto it. We'd make lame excuses – saying how badly we were needed inside – then hang our heads and tromp back out to the lot. At one point, George asked his wife Marcia – one of the editors on the show – to come down and take a look at things. She took one look at the Death Star surface and decided that the scale needed to be even smaller. We were already working with incredibly tiny pieces of Scotchlite – about three-sixteenths of an inch – so the modelmakers all went, 'Oh, no!' We went back in with a stencil

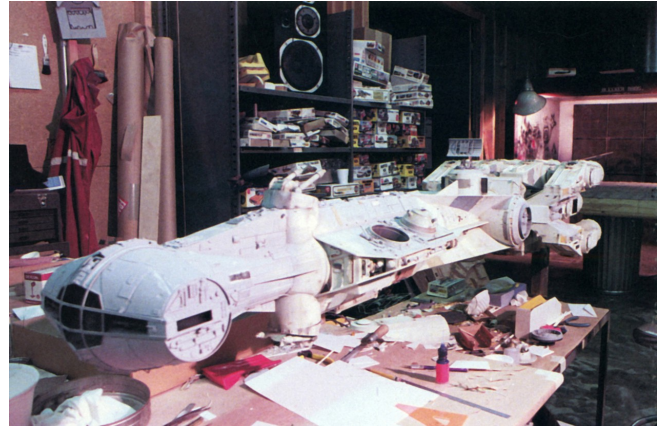
to block out part of the tape, then started making all those windows an eighth of an inch on each side.”

Although most of the Death Star footage was achieved on stage with the Dykstraflex rig, scenes incorporating pyrotechnics were accomplished outdoors in the parking lot. “With ASA 100 film stock,” Edlund explained, “we needed about a million watts of light to get an exposure shooting high-speed – so we had to go outside. The sun made for a wonderful key light, but we had to be careful about getting shadows from the camera truck cutting across the model.” A third-scale Death Star surface proved more manageable for some shots, as it could be propped against the side of the building to catch sunlight at the correct angle. Pyrotechnic blasts were filmed high-speed with a well-worn camera rented from Paramount. “I got this camera up to about a hundred frames per second, hung it upside down on a wire, and ran it down a trolley to photograph the explosions going off beneath. Inverting the camera allowed me to almost scrape the Death Star surface.”

For shots of the station’s powerful beam weapon charging, an old perspective trick was employed. “Grant McCune built a foot-long section of tube that was photographed through a beam-splitter,” Edlund noted. “There was a front-surface mirror behind the tube, so the interior reflected back on itself, making the tunnel seem to go back to infinity. I used Lin Dunn’s modified Cinerama camera for this, as well as for locked-off shots of the larger-scale Death Star cannons firing.” The recoiling cannons – with built-in lights to spot for laser animation – were replicated in smaller scale for inclusion as detail on the large Death Star foam panels.

Separate models were constructed for the Death Star trench, featured prominently in the finale. A

geography for the trench was first established – with certain stretches detailed more sparsely than others – then three entirely different miniatures were employed, with a retouched photograph of the trench serving as a backing for lengthy model passages. As shooting got underway on the trench, the team discovered that there was no way to hold an eyepiece to the camera as it tracked through the miniature. The solution came in the form of a device Edlund had created during a previous stint in the music world. “Richard had invented the ‘Pignose’ mini-amp,” Doug Smith



*Detailing on the Blockade Runner – as with other ships in the show – consisted principally of scribed surface panels and pieces appropriated from plastic model kits, augmented by hardware items from a nearby surplus store. In contrast to the pristine look typical of science fiction films at the time, the Star Wars models were airbrushed to impart a weathered and aged appearance.*



*With the Blockade Runner mounted upside-down to simulate zero-gravity conditions, an explosion is photographed on the bluescreen stage. After a series of primacord mishaps – resulting in the obliteration of dozens of breakaway models – pyrotechnician Joseph Viskocil was brought in to orchestrate the miniature explosions.*

related. “So when we had trouble with the eyepiece, in order to tell what was going on during this blind move, Richard put audio pickups near all the stepper motors. When he dialed up the roll axis, he could hear the speed of the motor as these mikes recorded it and blasted it out of the Pignose. By listening to the motors and determining the relationship between the motor noise and the camera’s physical movement, Richard was actually able to assemble the move.”

Most of the ship models – X-wings, Y-wings and TIE fighters – were shot separately using motion control and bluescreen. Among the largest of them was the Millennium Falcon – whose redesign by Joe Johnston was purportedly inspired by Lucas’ idea of a hamburger in space. “The original concept called for the Falcon to sail like a giant sunfish,” explained Lorne Peterson. “It would lift off on its horizontal axis, then rotate into a vertical configuration and fly upended on edge with the front mandibles pointed forward. We never actually shot it that way, though, because George decided he liked the look of it flying horizontally. But because of that original notion, the cockpit was capable of rotating so that the crew would be in the correct alignment for looking ahead in flight mode.”

Detailing of the Millennium Falcon was a collaborative effort, each section tackled by a different modeling team. “With so many of us working on different sections of the Falcon,” Paul Huston remarked, “we could have wound up with a mishmash – but instead there was a sense of varying personalities that enhanced the ship. Another thing that helped was that Joe Johnston’s design style had matured during his time on the project. It was as if he had worked through all of the clichés and gotten to the point where he was coming up with new things.”

At the height of the Death Star assault, the Falcon is seen diving out of the sun to rescue Luke from Darth Vader and his henchmen. “To get the lens flare around the ship,” Edlund revealed, “we shot two passes on the miniature. One was a regular backlit flyby. For the second pass, I put a mirror behind the ship that reflected a light for the sun element. The ship was silhouetted, so we had a great lens flare with a solid matte edge that we couldn’t have gotten any other way.” The most challenging Falcon flight was its hasty departure from the Death Star docking bay. “In terms of lighting and programming, that was a monster. The model had to rise, spin around on its rotator pylon, then go



*Modelmaker Steve Gawley hot-glues surface sections onto the open framework of the Imperial Star Destroyer.*



*For the film’s tour de force opening shot, the completed model was inverted on stage to facilitate an ultra-close camera flyby. While the effects team considered building a separate, larger-scale underbelly for the scene, a test using the three-foot model proved that its detailing was intricate enough to bear close scrutiny. Assistant cameraman Doug Smith readies the Star Destroyer for filming.*

into a different lighting situation as we pulled the camera away to make it seem like the ship was heading out into sunlit space.”

In shooting the spaceships, the stage crew found that the aircraft speeds in Lucas’ dogfight reel did not always translate well to their footage. “We wound up slowing down the action considerably to allow the audience to follow what was going on,” Doug Smith observed. “When we viewed dailies, all we saw was this muddy streak tearing across the screen. Of course, the final comps wouldn’t have looked as bad because there’d be a background to relate to; but this was the first time anyone had tried doing a whole show this way, and it really scared us into thinking that the ships wouldn’t read at all.”

Throughout the bicentennial year, ILM crew members continued to invest long hours in the *Star Wars* project. “Few of us were married, and none of us had children at that time,” Dykstra recalled. “It wasn’t unusual to spend eighteen or twenty hours at this super-garage working and the other four asleep on a cot. That was the work ethic of the environment, and it reflected my philosophy that the energy people put into a film cannot help but be seen on the screen.” With temperatures in the San Fernando Valley warehouse climbing well above one hundred, work during the hottest parts of the day proceeded slowly. “We got a rough reputation for being so unconventional with our procedures. We’d work until four or five in the morning, and not start in again until nine or ten – which seemed pretty strange to outsiders. Representatives from Fox would see some of our people tooling in late in the morning and come to the conclusion that we weren’t taking this seriously.”

It soon became evident that even with the Dykstraflex running optimally, a second shift would be needed. Dennis Muren took on the night shift, which overlapped with Edlund’s unit, working from three until midnight. “I believe John felt I was right for the project because my background in stop-motion indicated that I had an understanding of non-real-time applications,” Muren observed. “That, of course, would be useful in motion control programming.” Usually the two shifts worked independently. “We did our own foregrounds and backgrounds to make sure that the same personality was coming through in all of the elements. That was the true advantage of motion control – and something I didn’t become fully aware of until after the movie wrapped. This was a system that enabled an entire shot to be processed through a single person’s mind.”

The slow pace of motion control shooting severely limited the speed with which both day and night crews could work. “It was a rare night that we were able to shoot more than two stage elements,” Muren stated. “We had to be clever and tweak the moves – especially when we were shooting the peel-offs – so that people wouldn’t be seeing the exact same mechanical movement for each ship. Since we weren’t working in real time, we couldn’t always judge whether the accelerations and decelerations were following the laws of physics, so there were times when we got some jerky starts. We only had vertical and horizontal movement with the tracking camera; in order to get a diagonal motion we had to use these two perpendicular axes in tandem and get them to feather perfectly. There was some mechanical looking stuff that wound up in the film, but we strove to avoid it.” While Muren – assisted by Ken Ralston, another Cascade recruit who usually manned the computer – and Ed-lund shot on the Dykstraflex, Dave Robman used the modified Technirama camera to film an unending stream of background elements for later compositing.



As postproduction moved into high gear, Bruce Nicholson was hired on. Nicholson had spent a year as a camera assistant at the Ray Mercer & Company optical house before slowdowns left him unemployed. "I had done optical lineup and helped shoot some stop-motion," Nicholson remarked, "so I at least had some experience in the business. I got a tip about ILM and called up. Robbie Blalack and Dykstra interviewed and hired me. There was a methodology already in place, but it was still undergoing refinement, as they'd had a lot of problems in the beginning. Lenses had been custom designed for the printing equipment, but we had to institute quality control procedures to ensure that we didn't lose the Vistavision advantage of a larger image at our end of the process. And we had to process a lot of shots. With two shifts going, we'd be down for maybe four or five hours out of the day – and that time was used to keep the system maintained."

To relieve the pressures of the daily grind, crew members took refuge – and lunch – beneath a large oak tree in the parking lot. "We would sometimes do preposterous things to relax," Nicholson admitted. "There was a hot tub out there, and whenever someone got completely burned out, they'd just climb in. Right off, John told me there was no time clock. If I needed to get my car fixed or take care of some business, that was okay. I thought to myself, 'I'm going to like this place.' He knew he'd get our best – and that's what he got."

Fox was not so certain. After investing a million dollars and a year's time in the *Star Wars* effects – with only four completed shots to show for it – the studio stepped in and shut ILM down to reevaluate both the facility and the project. "Most of the time and money had been spent developing a working system," Jon Erland commented, "and, unfortunately, that system had only just gotten underway. Everybody was sent home to agonize over whether there'd be a chance to continue."

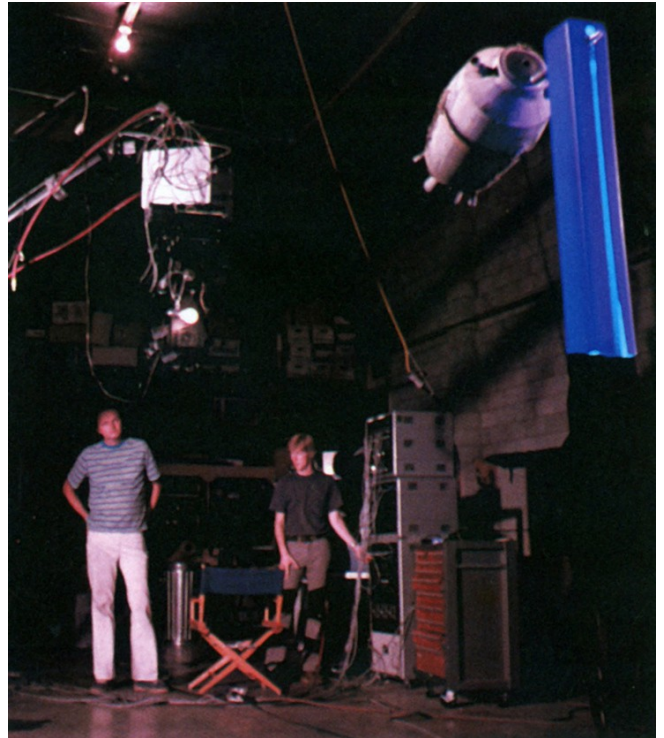
"There was not only the usual evolution that takes place during a movie," Dykstra noted, "but also the genesis of the tools being used. It wasn't just a matter of deciding where to put the camera – we had to figure out what the camera was. To explain all of this and put it down on paper so the studio could view our progress was just not possible. We forced them into a situation that ultimately resulted in a generally negative relationship between George and me. It wasn't a matter of personalities – although George and I are probably different types of people – and it certainly wasn't by design. We never set out to put anyone in a spot. It was simply that they had no choice but to trust us. If I were in George's position, I would have killed me – but he was forced to support me, whether he wanted to or not. He was in the middle, trying to protect his vision and his movie. Some thought that if I were fired, the rest of the crew would bolt – which would have been a real problem."

Fox opted to reopen ILM on a provisional basis, even though they had now come to see the company as a group of rebel misfits. "We had a group of dedicated people operating without any bureaucratic hang-ups," Paul Huston stated. "There were no artificial barriers to interfere with internal communications. As a result, almost everyone's work wound up being part of the finished film. There wasn't the usual dead-ending and waste that comes about in typical studio situations." Part of the bad blood may have stemmed from Lucas' vision of the film. The spaceships – both full-scale and miniature – were weathered and severely dinged up, as if they had been in operation for a long while and were badly in need of refurbishment. The look was unfamiliar to the studio because, with the exception of little seen films such as *Dark Star* and *Silent Running*, no filmmakers had attempted to portray such a cluttered and dirty future. With pristine visions of 2001 dancing in their

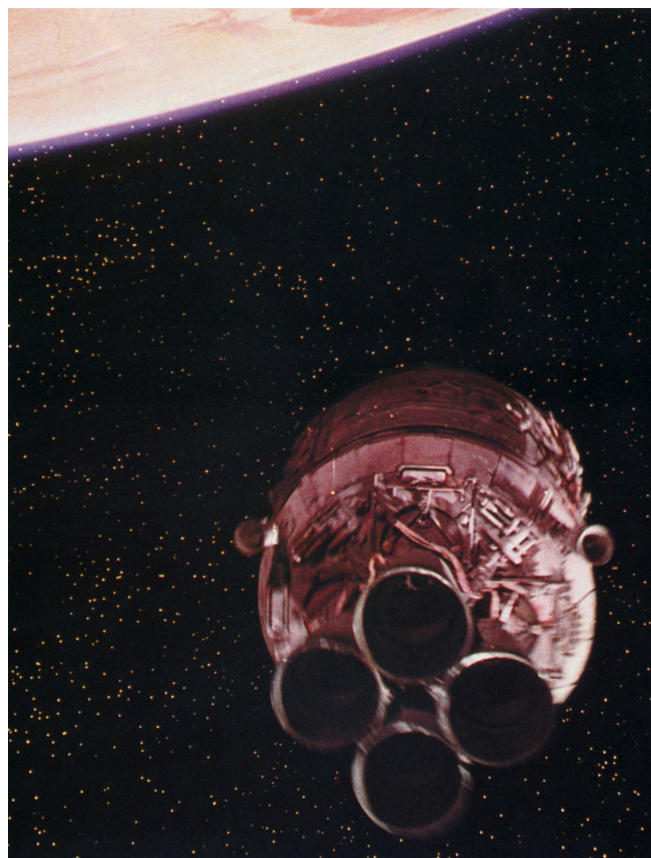
heads, Fox executives attributed the look of the models to poor workmanship rather than deliberate design. “George’s ‘used future’ look was enhanced by ships that took on the quality of a building with all its plumbing on the outside,” commented Lorne Peterson. “When they were lit properly, all this detail on the models showed up in strong relief, selling the mass of the spaceships. Having seen footage from real space missions, we knew that there would be hard, undiffused light raking everything and creating hard-line shadows.”



*Effects art director Joe Johnston designed spaceships and supervised the rendering of nearly a thousand storyboards for the production. For reference, he consulted illustrations by conceptual artist Ralph McQuarrie, as well as preliminary study models constructed by Colin Cantwell.*



*Early in the film, droids C-3PO and R2-D2 are ejected from the overrun Blockade Runner in a small escape pod. Second cameraman Dennis Muren and Doug Smith shoot the pod on the bluescreen stage. An advanced bluescreen setup and improvements in matting procedures were key to the success of the model photography.*



*A shot of the escape pod plunging toward Tatooine featured a planet matte painting rendered by McQuarrie.*

That lighting style became a matter of considerable debate. “Optical wanted a lot of fill – about a 2:1 lighting ratio,” Muren remembered. “But the ships just didn’t look good in that light. It was very ‘indoorsy.’ Plus, they wanted everyone on a one-light – the idea being that all of the opticals would be at one exposure so the comps would come through the same way. This was more of a theory than an application – it worked on 2001 with their held takes, but it simply couldn’t work here. Even normal variance in the lab work would have made it impossible. We wound up shooting the ships with a heavy key, minimal fill, and the best exposure we could manage. Then it was up to optical to somehow make it work. That was part of the learning process – some of our guys didn’t yet realize you could overexpose or underexpose and then correct

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It was on a day in the dead of summer that Joe Johnston raided the surplus store across the street, returning with an escape chute from a Boeing 747. With temperatures inside the non-air-conditioned building well above one hundred degrees, sweltering crew members inflated the chute and mounted a water hose at the top, then stripped down to their underwear and took turns on the makeshift water

for that. They also didn’t understand that you could color-correct footage shot under different color temperatures – which, of course, had to be done for the stuff the day shift shot in the parking lot.”

For Muren, the principal frustration of the show lay with the tiny mechanical failures that could instantly end a full night’s work. “We’d be all set and then a chip would blow. It was incredibly annoying. I’d have Ken Ralston tape it on top of the controller with a note indicating that not having a spare for this six-bit part kept us from shooting. It made me want to just grab a high-speed Bolex and some extra lights to boost us up to f/22. Then I could’ve put an X-wing on a wire and Lydeckered the ship through.”

The animation department would eventually be called upon to hand-articulate enormous numbers of mattes to correct for blue spill and sundry other optical defects. Adam Beckett, who had been teaching at CalArts and doing work for Bob Abel, headed a department drawn from a pool of his former students. Among them was Peter Kuran, who showed up for his interview with Dykstra with a reel of 16mm film showcasing his work. “At the time, I had this really crappy cement splicer,” Kuran recalled, “and when I ran my film for John, every splice broke. It was unbelievably embarrassing. Finally, I just told John that if he hired me, I’d work for free for a week. If he didn’t like my work, he didn’t have to pay me. My work turned out okay, and I came on for \$160 a week. Later on, I found out that almost everyone else was getting \$320 per week.”

Initially, Kuran was intimidated by the prospect of joining a crew that had already been in production for a long time. “My big fear was that everyone else would know what was going on and I wouldn’t have a



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clue. But, in fact, no one knew what was going on. I spent the first week inking and taping the ship lasers. This was one area that was pretty much locked in – but after seeing these things, it was clear to me that they lacked perspective. The beams were just on and then off, without any gradual diminishment. So I went in one night and put a shot together in which the lasers receded in proper perspective. They were kind of pissed that I went off and did this – but the next day I was put in charge of spaceship lasers."

From there, Kuran grew more bold with his enhancements, adding interactive light and shadows to the model shots. "I got tired of doing lasers very quickly. I looked at some comps, and it seemed to me that they were missing something. The elements were all there, but they didn't seem tied together in the same space. So I put interactive glows onto the ships getting hit by laser fire, and that seemed to make it all come together. After seeing the shots with animated interactive light, Richard and Dennis started incorporating interactive light into their own stage elements."

The *raison d'être* of the animation department changed as the production progressed. "Adam Beckett's forte was animated explosions," stated Kuran, "and that was initially our aim. They had put primacord in the models – which didn't explode the ships so much as shatter them. The hope was that animation would fill the explosion out, creating a sort of gaseous visual. They went through many models and a lot of bluescreens, because primacord is overkill for something that small. When the models shattered, the debris became lethal projectiles, ripping through everything."

“None of us had any experience shooting miniature explosions,” Edlund admitted. “All I knew about primacord was that it went off at the speed of sound and was used to cut really big trees in half. Greg Auer – who staged some tests with a 707 airplane model – was planning to use a foot-long piece of primacord, while I thought about a quarter-inch piece was all that would be needed. We compromised with a three-quarter-inch piece. I filmed it, figuring that at 144 frames per second the camera might get something good. But when we screened the shot, it went from a view of the plane to nothing at all in exactly one frame.”

*droids as salvage. The enormous Jawa Sand Crawler on which they are transported – part of which was built full-size for the live-action shoot – was rendered in its entirety as a radio-control miniature and shot in the Mojave Desert.*

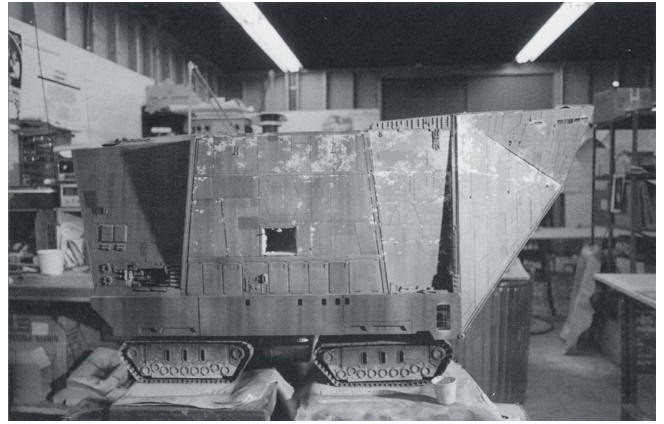
*Millennium Falcon – the souped-up pirate ship belonging to mercenary Han Solo – which went through a prolonged conceptual phase before George Lucas and his design team arrived at its final configuration. Grant McCune readies the model for filming.*

*Millennium Falcon model for a motion control bluescreen shot.*

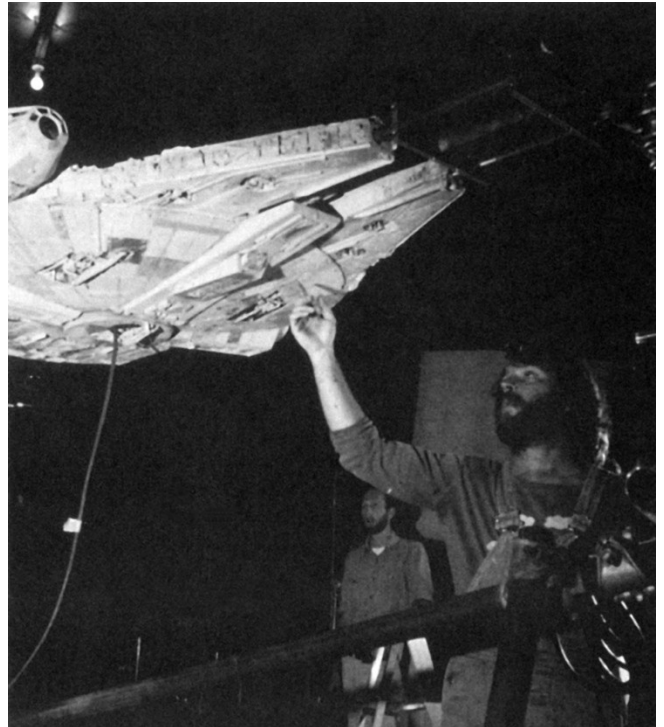
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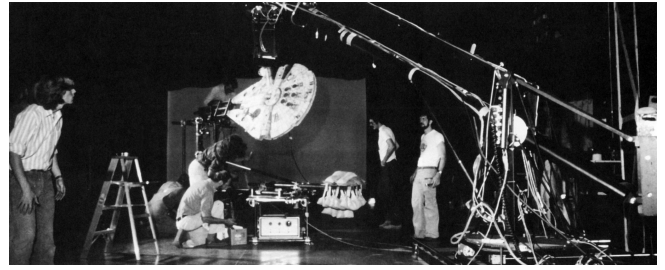
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There were some tough sessions at ILM when principal photography concluded in London and George Lucas returned to begin evaluating the quality and volume of his effects team’s work. “Every Monday, George would review the previous week’s shots,” Doug Smith related, “and early on, there was a lot he didn’t like at all. We’d find ourselves redoing many shots we thought were finished and out of the way. I remember Richard saying, ‘I can’t take too many more of these Mondays.’”

“We had this new, very complicated machine that George was relatively uncomfortable with,” remarked Edlund, “and I felt that unless he understood its limitations and capabilities, he would be hampered in knowing what to ask of it. So we decided to suggest that he spend some days with us setting up shots and programming moves and so forth. George thought it was a good idea. For about



First cameraman Richard Edlund and his crew prepare the Millennium Falcon model for a motion control bluescreen shot.

a week he came down and spent all day with me on the set. I would go through a shot and talk about how we were going to set it up. Then I would put the model up, shoot an element, do an RAR and run it on the Moviola with other elements in the shot. George could then look at it and tell us if he wanted anything changed. By being there, he was able to appreciate what the process entailed and determine for himself how much time we could afford to spend in perfecting each element, considering that we had a thousand or more of them to do. It was a useful exercise – and we were able to develop a creative language, based on the equipment, that was very valuable, especially when George headed north to Marin County to cut the film.”

It was about this time that ILM faced another crisis in the form of a visit from leaders of four union locals. “I’d had some problems with the camera union in 1968,” Edlund admitted, “mainly over the length of my hair. Though I’d resigned immediately afterward, when *Star Wars* came along I notified the local about it and informed them of my position on the show.” Due to the unique requirements – photographing miniatures with computer controlled cameras – the union determined that it was unlikely a union member would qualify for the job, and that Edlund could accept it.

But more than a year after ILM opened, its ongoing existence was threatened when the union leadership insisted upon inspecting the facility to see whether unemployed members would be suited for the jobs now filled by outsiders. To graphically demonstrate the degree of sophistication in the work being done, Edlund provided the union officials with a surprise. “We had the motion control system running like a champ by then. The day before they came to make their evaluation, I programmed a very elaborate move on the Dykstraflex that I could actuate with the push of a button. After I had walked them through, I stopped next to the computer and started the program. I kept the group positioned in a way that they would see the camera coming down the track toward them. They had been kind of nonchalant about what we were doing there, and it didn’t look real good for us at that point; but when this big camera – on automatic, mind you – came cruising past and did a one-eighty so it was staring right at them, they were speechless. They couldn’t believe we were capable of work like that – that anyone was at that time.” Several weeks later, the union notified Lucasfilm that the entire ILM crew would be absorbed into the locals.

Citing a need to reshoot certain live-action scenes, as well as establish an additional effects unit, Lucas pleaded his case with Fox for additional funds – but wound up with only a fraction of what he sought. Those scant resources were sorely stretched as Lucas attempted to improve and extend certain scenes he found lacking – among them, the impoverished can-tina scene. Rick Baker was called in to set up an impromptu creature shop with Jon Berg, Laine Liska, Doug Beswick, Tom St. Amand and Phil Tippett. “We worked from Ron Cobb concept drawings,” Tippett recalled, “plus some odds and ends of Rick’s.” Dozens of creatures were fashioned in the crew’s rush to meet Lucas’ deadline. “We busted our asses for about six weeks, sculpting and molding this stuff, then hauled it down to a little insert stage on La Brea for two days of shooting. George pitched right in, telling us that putting the slime and the eyeboogers on the monsters was the fun part of filmmaking. It was very informal – and it was exactly what we’d all wanted to do, which was work on theatrical science fiction movies.”

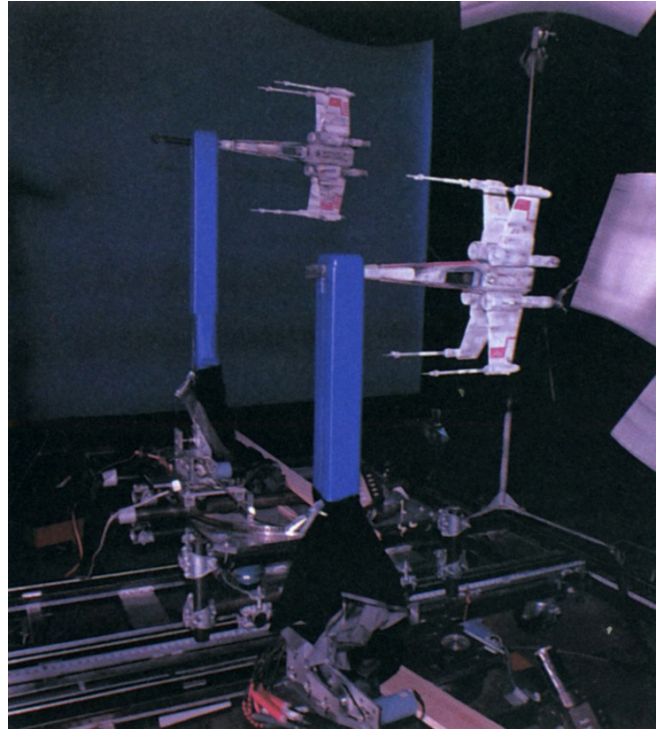




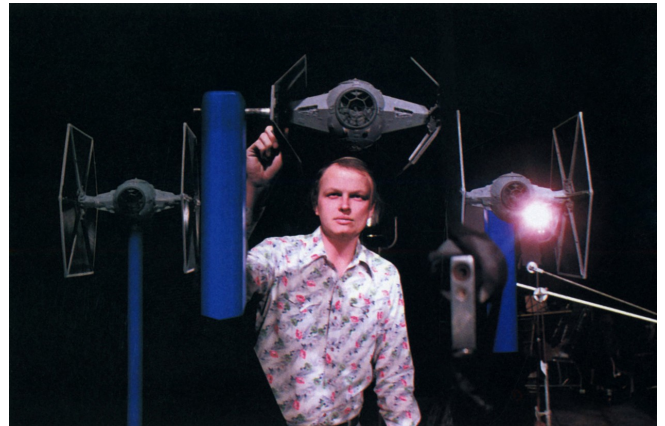
*For a scene in which Chewbacca engages in a futuristic game of chess, puppets representing game pieces were stop-motion animated by Phil Tippett and Jon Berg. The animation was rephotographed off a television monitor to suggest a holographic look, then superimposed over the live-action.*



*Long shots of the Imperial Death Star employed a three-foot plexiglass sphere. Dennis Muren takes a light reading in preparation for filming.*



*In a climactic sequence, Rebel fighters navigate a narrow trench to infiltrate the Death Star – a sequence accomplished with motion controlled ship models composited into separate motion control trench photography. To minimize the need for rotoscoping, the models were mounted on internally-illuminated blue pylons.*



*Muren composes a configuration of TIE fighters on the bluescreen stage. When feasible, ships were shot in groups to limit the number of composite elements.*

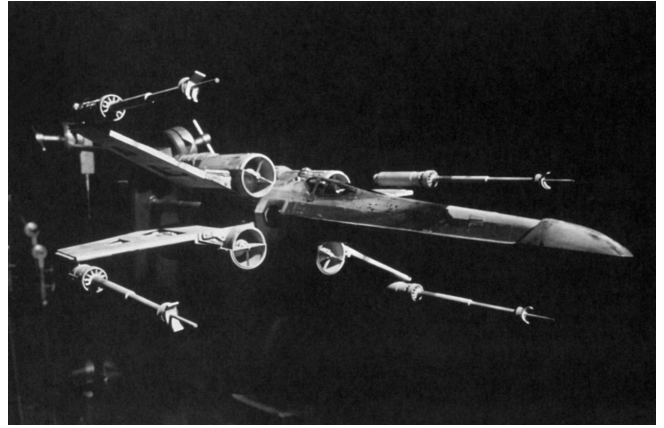
The creature crew was pressed into acting service as the bug-headed band of swing players. “We were sweating like mad inside these latex masks,” Tippet commented, “so they filled up with moisture, causing us to choke on our own juices. We couldn’t get any air and we couldn’t see anything because the eyepieces were fogged. Suddenly, this blessed rush of air came in, but we didn’t know how or why – we were just relieved to be able to breathe. Then, when I could see out of the mask again, I saw Gary Kurtz using a razor blade on one of the other guy’s necks to cut an air hole for him. I got a little freaked out when I realized that the executive producer had been working an inch away from my throat with a very sharp blade.”



*Imperial TIE fighters chase Rebel attackers through the Death Star trench.*

Matte paintings served to finish off many of the still uncompleted shots. During preproduction, Jim Nelson had contacted Harrison Ellenshaw, who was running the Disney matte department, and talked to him about doing paintings for *Star Wars*. “Jim got in touch while ILM was still being set up,” Ellenshaw recalled. “Ralph McQuarrie had finished his conceptual illustrations and was gearing up to do some matte paintings, but they wanted a matte artist who already knew how to assemble the shots with live-action footage. Jim showed me Ralph’s incredible artwork; and that, combined with my love for *American Graffiti*, really sold me on being a part of this movie. But then I didn’t hear back from them. I figured someone else had gotten the job since they were doing matte shots in England and they’d need the matte artist there supervising the setups. But it didn’t work out that way. Towards the end of production Jim called back. I was a bit put out – after all, he was asking me to come look at someone else’s plate photography. But I was amazed to find that these plates had been shot just as I would have. George obviously knew where to put the camera for a matte shot. To this day, he’s still one of the few directors I’ve worked with who can put the camera in the right spot.”

Permitted by Disney to moonlight, Ellenshaw accepted the *Star Wars* assignment, rendering the majority of his paintings on the ILM premises, but some of the more complex shots at the Disney studio. At Disney, Ellenshaw had worked with rear projection, using Vistavision YCM separations; on *Star Wars* he used a bipack setup, painting on the same stand he would then use to photograph the mattes. “I asked my Disney cameraman, Bill Kilduff, to go over with me at night to do the wedges and compositing,” Ellenshaw related. “Dykstra, Edlund and Dick Alexander had put together a terrific matte stand for me, but the problem with the Van Nuys location was that the matte department wound up being upstairs. We had to have a lockedoff, rock-steady bipack camera to do this work; but being on the second floor, we found that every time someone slammed a door downstairs, the camera or stand would vibrate and we’d have to start the shot all over again. After a while, we had signs up everywhere, saying ‘Don’t Slam the Door.’ Those would be effective for about a day. Then the only thing we could do was put up bigger signs and add expletives.”

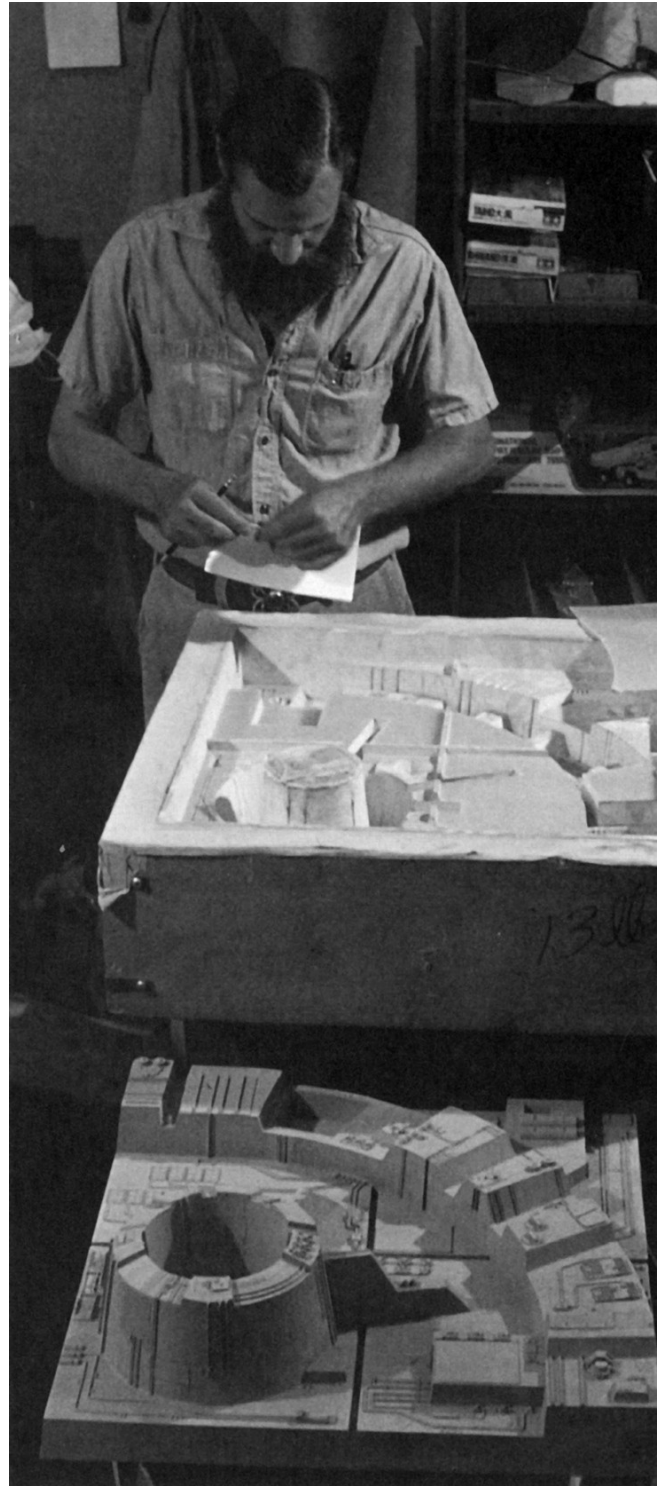


*Budget and time restrictions limited the number of models that could be constructed. Motion control technology, however, enabled the effects crew to photograph single ships as individual elements, then layer those elements with others to create the impression of entire fleets of spacecraft.*



*Grant McCune details one of the X-wing models.*





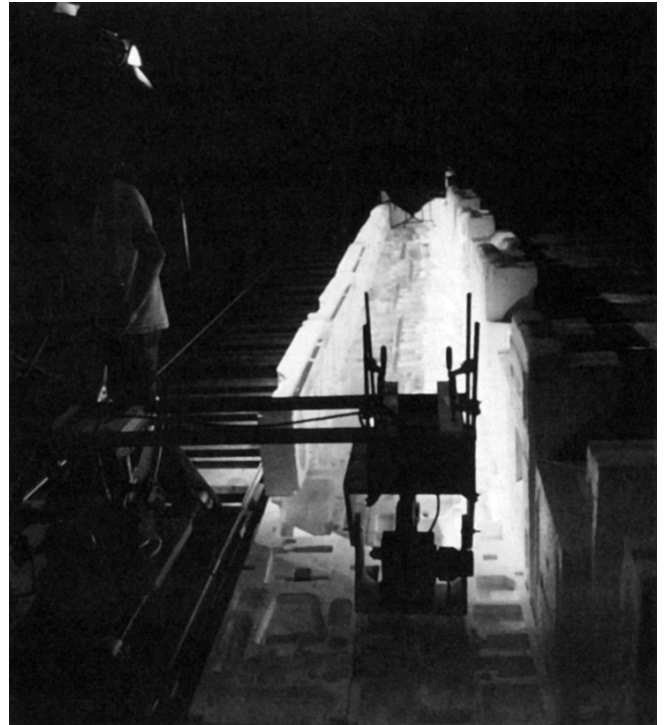
*For shots of the Death Star surface, modules that could be reconfigured in a multitude of ways were sculpted out of foam and then replicated. Detailing of the assembled forty-by-sixty-foot miniature was an arduous process that consumed months. Model builder Jon Erland makes castings for the Death Star miniature.*



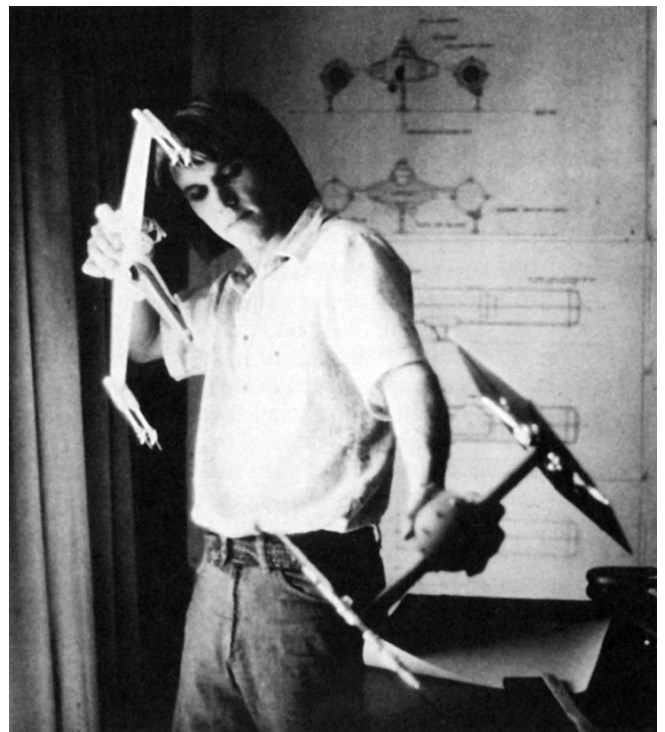
Like most members of the crew, Ellenshaw was much in the dark about the film, even as he worked on it. “We didn’t know much about the storyline or the performances because George was being so secretive. Then I happened upon a storyboard featuring the Wookie Chewbacca, and that really made me have doubts. I thought it was a huge mistake. *King Kong* had just been bashed critically, and here was some kind of monkey-thing. I thought, ‘Why would you put something like that in a space film?’ Shows what I know.”

Late one night, Ellenshaw and a few others got a chance to view a portion of the film. “We had a black-and-white partial mix of reels five and six. There were maybe seven or eight of us there, and someone said, ‘Let’s run some of this.’ We’d never heard the film before, or seen any non-effects footage. So we ran this footage – it was the prison rescue – and the reaction was kind of like, ‘Uhhh?’ After that, nobody thought the picture was going to be a big hit.” Pete Kuran concurred. “Darth Vader sounded like David Prowse muffled. All of the creatures spoke like regular people with masks on. There was temp music, but still the picture just sat there. It just goes to prove how much music and sound effects help a movie.”

Not everyone was inclined to write off the picture before it was finished. Richard Edlund was unswerving in his conviction that it was going to be a blockbuster. The signing of Alec Guinness – the distinguished British actor and Academy Award winner – to play Obi-Wan Kenobi had been more than enough to erase any doubts he might have had. “I always thought it was a good project,” Edlund affirmed. “I liked the idea of the heroes and the respect for one’s elders and all those kinds of things that, I felt, were going out of society at the time. But there were lines in the script that I knew were going to be tough for an actor to pull off. ‘Trust in the Force, Luke.’ How many actors can deliver a line like that? When I heard that Alec Guinness had been



*Separate surface models were produced for shots of X-wings and TIE fighters navigating the Death Star trench. The sequence was first choreographed in a series of tests executed on a mockup made from motorcycle packing cases.*



*With X-wing and TIE fighter in hand, Joe Johnston works out a shot for the aerial dogfight.*

cast, I said: 'Guys, this is going to be a hit. We're going to unseat the shark as the number one picture.'

For many on the crew, the first coming attractions trailer was a major revelation. Kuran, who had worked as an usher at the Avco Theater in Westwood before starting at ILM, was invited back by his former co-workers just to view it. He was blown away, hardly believing this was the movie he was working on. Eventually, the trailer found its way to ILM. "The copy we got was a high-contrast black-and-white print with music from 'The Planets' by Gustav Holtz," recalled Lorne Peterson. "When we heard that music coming from the screening room, everyone would come running." The effect was therapeutic. "Whenever somebody got really depressed," Ellenshaw remarked, "we'd run the trailer to cheer them up. I even brought a couple of friends over one weekend and ran it for them, just to enjoy their reaction."

Since storyboards had been revised after the completion of plate photography, there were usually solid reference materials for Ellenshaw to draw upon as he worked. In the case of a shot of the Millennium Falcon in the Death Star docking bay, however, he painted with only an incomplete view of his subject to rely on. "Right after my first set of dailies – which George and everyone else responded very well to – we screened this shot of the Falcon where I had painted two cockpits, one on each side. Everybody started laughing when the shot came on, and I was thinking: 'My stuff is so bad they're laughing at it!' George just told me to go look at the model, which had already been put under lock and key someplace." Access to the models proved useful later, as well. When a matte shot of Jawas approaching the Sand Crawler was needed, Ellenshaw simply took a still of the model, mounted it on glass, and painted over it.

With the studio maintaining a tight-fisted attitude towards the production, funds for second unit work were only sparingly allotted. Thus, when the time came for a second unit shoot in Guatemala, where the jungle surrounding the Rebel base on Yavin was to be filmed, only Richard Edlund and Dick Alexander were sent to photograph the required plates. "By this time, most of the show was in optical, so they could afford to let us go," recalled Edlund. "With a production scout, we went to the Mayan ruins at Tikal. There we met up with Lorne Peterson who was on vacation by now and decided



*Filming of the trench miniatures was effected by suspending the motion control camera from a boom arm, Richard Edlund prepares to shoot a pass on the stage model.*



*Pyrotechnic explosions on the Death Star surface – executed by Joe Viskocil – were filmed highspeed to sustain a sense of mass. To insure adequate illumination, a surface miniature was set up in the facility parking lot*

to join us on his own. We hired some local peónes and schlepped our incredibly heavy Technirama camera – in its case with a two-hundred-foot magazine and a car battery to run it – to the top of a giant pyramid still covered over with jungle. As a lookout post, we erected a pole with a glorified trash can on the end of it that the model shop had made, and Lorne got to play the guard. We were there for about ten days and did a bunch of shots – three or four of which wound up in the movie.”

*so that the sun could serve as a key light. Edlund rigged an inverted camera on a cable and trolley, then ran it over the model as pyro charges were detonated.*

*For some shots, the surface miniature was propped upright to achieve more desirable angles of illumination.*

As a rough cut of the film came together, Lucas determined that he needed numerous insert shots of data screens. Earlier he had spoken with John Wash, a young artist who had worked for a division of Universal that produced industrial films. “I studied at USC – learning to use animation cameras for graphics effects – and heard through the grapevine that George was looking at graphics and animation reels,” recalled Wash. “I met with him to talk about the computer simulation of an attack on the Death Star that was to be shown in the Rebel preflight briefing. I got together with a Universal associate of mine named Jay Teitzell, and we worked up a methodology for the graphics based on their script descriptions. We settled on a traditional animation approach to simulate computer graphics for the flight down the trench towards the access port. We submitted a bid, but George decided to go with Larry Cuba for the bulk of the briefing graphic, which was rendered using real computer graphics.” Employing a Data General vector display – a far cry from the types now commonly utilized – Cuba produced a deliberately crude CG representation to fit 1977 audience expectations of computer imaging.

Nine months after his initial conversations with Lucas, Wash was again contacted to work on the movie – this time by *Dark Star* writer and co-star Dan O’Bannon, who had been asked to contribute graphics for cockpit displays. “Dan is very creative, but he’s not a nuts-and-bolts guy,” stated Wash. “He had done down-shooter animation for *Dark Star*, but this was not really his forte. I talked with Jay about it, and the three of us got together to produce these cockpit display graphics. We sent over a few early efforts to be rear-projected into sets – like they’d done on *2001* – but those didn’t work too successfully. Most of our graphics ended up being matted into previously shot blank screens. Some even got comped into matte paintings of instrument panels, while others cut in as full-frame displays.”

Lucas laid down specific ground rules for the look of the readouts. “George’s graphic design sense is just tremendous,” Wash remarked. “The instrumentation in the cockpits echoed World War II fighter plane dashboards, projected forward in a futuristic way the audience could easily grasp.” Lucas felt very strongly that no recognizable alphanumeric should appear in the displays, but eventually conceded to the use of Arabic numerals in order to quantify distances and times for the audience. “George wanted as little relation to our earth system of lettering as possible. So we created an alien-looking system from segments of numbers and letters, which gave us some interesting elements. We’d mix part of an ‘R’ with an ‘S,’ flipping these letter parts upside down or backward. Before we knew it, we had an alien alphabet with no identifiable relationship to anything else on earth.”

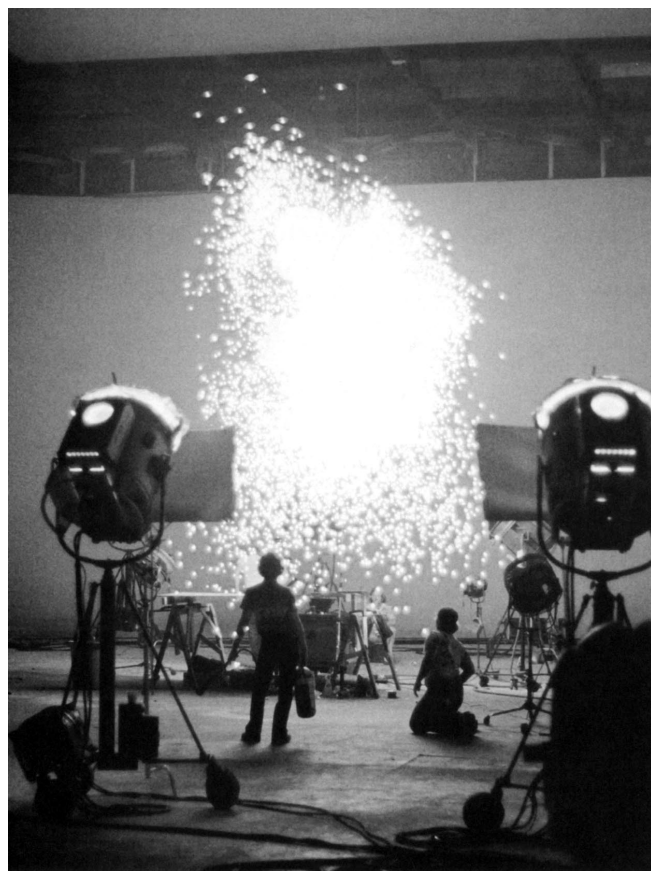
More elaborate means were used to render graphics for the large screen reviewed by Governor Tarkin as the Death Star orbits Yavin. “We went to Image West to use an analog computer system

called Scanimate that was employed to good effect in TV commercials back then,” Wash recalled. “This was one weird device. What it did, essentially, was turn high-con art into silly putty. We had no idea what the technician there was doing, but he used all kinds of patch cables and twisted dials right and left as we built this image up element by element. We spent eight very intense hours there putting that display together.” As production deadlines loomed ever closer, O’Bannon asked Lucas what would happen if their graphics failed to come together in time for the final negative cut. “George looked at Dan very calmly and told him that he would have a title card made up saying that the scene was missing because Dan O’Bannon screwed up.”

As 1977 rolled around, Lucas continued to change and refine the film, now scheduled to hit theaters in May. One late-breaking idea involved the holographic chess game played by R2-D2 and Chewbacca aboard the Millennium Falcon. “While we were still sculpting cantina creatures,” Phil Tippett recalled, “George came by and saw these little puppets sitting around. He had wanted to do a chess game with live figures supered over a chessboard, but *Futureworld* had beat him to it. George studied the puppets for a while and then asked if any of us did stop-motion work. There was a moment of silence while we all thought, ‘This is too good to be true.’ Then we replied, ‘Yeah ... yeah, we do stop-motion.’ So we got some neat little designs together, along with an old creature I had already fashioned, and wound up shooting the chess sequence at ILM the day of the wrap party.” Animated by Tippett and Jon Berg, the puppet chess pieces were filmed by Dennis Muren and then reshot off a television monitor to create a holographic look before being superimposed over the live-action.

Though the effects work was drawing to a close, the knockout scene that would open the film had yet to be done. “For the longest time,” said Pete Kuran, “the movie began with a ‘scene missing’ card. The big opening flyover hadn’t come together as yet – which really pissed off the people at Fox. To have the movie begin with ‘scene missing’ seemed like a joke.”

In part because the opening shot would establish the credibility of the film’s effects, about a year and a half of discussion preceded the actual shooting of it. “We talked about building a huge model on the side of the wall and raking the camera past it,” Edlund recalled, “but the length of track we had wasn’t sufficient to pull that off.” Another approach was tested using a three-foot Star Destroyer model. “I had Grant make up a tiny Blockade Runner, about an inch or so long, then attached it by wire to the Star Destroyer. The ship had only been finished on one side, so everybody had to rush like crazy to do a super detailed job across the belly, which the camera – with its tilting lens board to carry focus – missed by something like a sixteenth of an inch.” The proof-



*To create the effect of explosions in the zero-gravity environment of space, pyrotechnic charges were detonated above high-speed cameras shooting directly up at the*

of-concept test was a success, and only five takes were required to capture the lengthy overflight on film.

By February 1977, an enormous amount of rotoscope work still remained. The cockpit bluescreen footage featuring the actors was the most problematic. “The sets were very shiny and served to reflect the blue backing,” Bruce Nicholson explained. “Added to that was the fact that they were using frontlit bluescreen and a tremendous amount of light because they had to carry depth of field all the way to the back of the cockpits. They actually did a good job of shooting it, given all the limitations. Stanley Sayer, a British bluescreen expert who had worked on the Bond films, got an acceptable blue exposure out of it; but we still had all these holes to fill.”

In the time-crunch of the production’s final days, Ellenshaw was prevailed upon for a last-minute save. “George knew what was and wasn’t possible with effects,” Ellenshaw remarked, “so there were very few salvage jobs. But just before the cantina sequence, they needed a Mos Eisley exterior. The only shot they had outside the cantina had the principals in view – but this was supposed to be their establishing POV. There were only about four days left in the schedule when we got this. They’d tried to fix it optically and it hadn’t worked. So I did a little matte painting over the actors to get them out of the shot. I painted it squeezed because the anamorphic lens wasn’t set up – then we did it as a bipack. The show was finally done.”

ILM had gone the distance – but come in just under the wire. At the cast and crew screening, response to *Star Wars* was intense. “When I first saw the film,” John Dykstra recalled, “I was more concerned with matte lines than the story. But with the crew screening, it was amazing to see and hear people who worked on the film respond to particular shots. It was such a participatory movie event – even more so when I went to a public screening. I felt so good about the finished product that for a while I couldn’t get my head through the door.”

After the film’s release, Dykstra retained several key crew members from ILM, as well as its base of operations, to pursue work on *Battlestar Galactica*, a TV series noteworthy only for the lawsuits it triggered and the visual effects that Apogee – the new name for Dykstra’s unit – provided. “Lucas actually rented the facility and equipment out to Universal before realizing the similarities between his film and the series,” Jon Erland remarked. “Then this splinter group of Dykstra’s stayed south, while others headed north to San Rafael at Lucas’ behest to begin preparing the second *Star Wars* film. George was rich enough to do whatever he wanted – and he wanted to leave Los Angeles. With the original unit so divided, the question then became: ‘Which of these groups is ILM? Just who actually did the effects in *Star Wars*?’” Apogee continued on its own course, eventually spreading out to several neighboring buildings before disbanding in 1993. Grant McCune Design now resides in one of the structures, while the original ILM super-garage remains what it had been before the *Star Wars* days – an unoccupied industrial building.

*blasts. On a rental stage with a high ceiling, effects crew members film an explosion for the final destruction of the Death Star. The isolated element was later matted over model photography of the battle station. A similar approach was employed on scenes requiring the destruction of Imperial TIE fighters.*

*Joe Viskocil and Joe Johnston rig pyrotechnics onto a Rebel X-wing model. Unlike the Death Star and TIE fighters, all of the X-wing and Y-wing explosions were achieved by actually detonating prescored models.*

*In a trial approach that was ultimately abandoned, a camera is dollied quickly towards an exploding TIE ship model on the bluescreen stage.*



“Despite the challenges and difficulties for this young crew of seventy-five,” Steve Gawley reflected, “there was a genuine desire on the part of everyone to make these shots work for George. People put in long hours, and even worked holidays, to get the job done. They worked hard, and in doing so solved problems and created whole new techniques for effects photography that had never been tried before. It was an immensely creative environment to work in. And who could have guessed that this film we were doing would act as a catalyst for a whole new industry in Hollywood filmmaking – but it surely did. Back when *Star Wars* was being done, there were maybe three or four effects companies. Today there are more than ninety.”

*Star Wars* photographs copyright © 1977 by Lucasfilm, Ltd. All rights reserved. Production photography courtesy of John Dykstra, Dennis Muren, Steve Gawley, Lorne Peterson, Joseph Viskocil and Harrison Ellenshaw. Special thanks to Jeanne Cole, Lynne Hale and Halina Krukowski.

# Dennis Muren Playing it Unsafe

image

article by  
Don Shay

If Academy Awards are the benchmark of cinematic achievement, then Dennis Muren is a force to be reckoned with in filmmaking circles. Winner of more Oscars than anyone else alive, he has carried away eight of the treasured gold statuettes in the past sixteen years. Those who consider the bottom line a more fitting measure need only scan the top ten moneymaking films of all time to find Muren a visual effects principal on five of them. Expand the field to twenty and include a few more – three *Star Wars* movies, an *Indiana Jones* adventure, *E.T.*, *Terminator 2* and *Jurassic Park* – all landmark effects films bearing the singular signature of Dennis Muren.

Though his name is now synonymous with high technology, Muren's initiation into filmmaking was anything but. "The first movies I remember seeing were special effects movies – *The Beast From 20,000 Fathoms* and *The Maze* and *The War of the Worlds* all came out around the same time, when I was about seven or eight. I'm sure I saw other movies, too, but the ones that stuck with me were the effects spectacles. To recreate some of that magic, I would go out and get model kits and take photos of them using my dad's camera. I remember the first thing I shot was a plastic rocket sitting on a table in front of my bedroom window. It was an attempt to copy something I had seen in a movie – *Conquest of Space*, probably – and the result was just a silhouette against a white background."

Muren was nine or ten when his parents bought him his first movie camera – a used 8mm Keystone that set them back ten dollars. "By then, *Earth Vs. the Flying Saucers* had come out, and I remember trying to imitate it. I also attempted my own version of *The 7th Voyage of Sinbad*. The Keystone didn't have reflex viewing, so the parallax was always off; and it wasn't capable of single-frame exposure – which made stop-motion difficult. If I started and stopped the camera as fast as I could, I'd still get about three frames, with the first and the last being way overexposed. The result was pretty awful, but to me it was still very exciting." A couple of years later, the Keystone was retired in favor of a Yashica 8mm reflex with a zoom lens. "You couldn't focus with the reflex, but at least the parallax problem was resolved. And it had a single-frame device and could shoot high-speed up to 48 frames per second, as I recall. I did a lot of stuff on that, imitating Ray Harryhausen's *Gulliver and Mysterious Island* and Jason, and doing a lot of John Fulton and Lydecker stuff with miniatures and explosions and such. The hardest part was getting information. I didn't know anybody else who was doing what I was doing, and there was very little being written about effects at the time. So I had to figure things out on my own a lot – which was good experience."

Information came a bit easier when Phil Kellison, a veteran effects artist, moved into Muren's La Cañada neighborhood and struck up a friendship with the fourteen-year-old enthusiast. Kellison was working on *Jack the Giant Killer* at the time; and through him, Muren came to know Jim Danforth, one of the best of the new breed of stop-motion animators. "After spending years trying to figure out, on my own, how effects were done, it was really amazing for me to visit Project Unlimited,

when they were doing *Jack the Giant Killer*, and see the whole process all spread out, with cameras and projectors and rear screens and foreground sets and puppets.” Later, during high school, Muren would work part-time for Kellison at Cascade Pictures, then full-time after graduation, animating Pillsbury Doughboy commercials and dancing bed sheets for Bold detergent spots. There his circle of friends expanded to include David Allen, Phil Tippett and Jon Berg.

At home, Muren had graduated from 8mm to 16mm with the acquisition of a used Bolex camera. “After shooting all kinds of things over the years, it occurred to me that it was kind of a waste not to have an audience for it. So I got together with Dave Allen and Mark McGee – and Jim Danforth, to a certain extent – and we decided to do a low-budget film with the idea of selling it to ‘Creature Features’ on Channel 11 for enough to get our money back.” Bankrolled by a \$3500 inheritance Muren had received from his grandfather – ostensibly to be used for his college education – the group commenced work on *Equinox*, an effects-laden tale of archaeology students who confront a rash of satanic creatures while searching for a missing professor. Muren was the director, McGee the screenwriter and Allen the stop-motion creature creator. All would participate in the ambitious effects work. “We figured we could do the film in three months – in the summer between my freshman and sophomore year at Pasadena City College – but that was a naive estimate. About a week into shooting, it became obvious that the script was too short. At the rate we were going, the movie would have been about twenty minutes long. So we’d write another sequence and shoot it, then write another sequence and shoot that. School started back up, and I’d have to gather the actors up for a weekend and shoot another three minutes of the thing. It took about two years to finish the project, and one of the things I learned was that I liked doing effects a whole lot more than directing – but I came out of the film with much more respect for directors and writers than I had ever had.”

With his 16mm opus in hand, Muren spent the next two years trying to find an audience for it. “No one would buy it. ‘Creature Features,’ I discovered, bought their movies as package deals – they’d take nineteen bad movies to get one good one – and there was just no interest in a one-off film. I showed it to a lot of people, and in doing so, really got to know the Eddie Wood side of Hollywood. You’ve made this movie and you love it; and yet you show it to people and they just don’t see it.” One person who did see something in *Equinox* was Jack H. Harris, a genre producer whose reputation had been built on shoestring classics such as *The Blob* and *Dinosaur*. “We had three scary monsters in the picture; and Jack said that by putting those on the poster, he could get people into the theater.”

Muren turned *Equinox* over to Harris with the understanding that some editing and additional footage would be required before it could be released. Harris hired Jack Woods – a sound editor with directing aspirations – to oversee the alterations. Woods cut about fifteen minutes from the film and replaced it with thirty minutes of new footage, so that some scenes now had shots of the young actors filmed four years apart, intercut so that their age differences were pointedly evident. The film was blown up to 35mm, redubbed and given new music. “It’s a different movie than the one we made – more mean-spirited, with a devil character trying to get the girls, and other things designed to make the film more commercial. It was probably for the best. Our film was much softer and more naive. All we were trying to do was keep people from leaving the theater between effects sequences.”

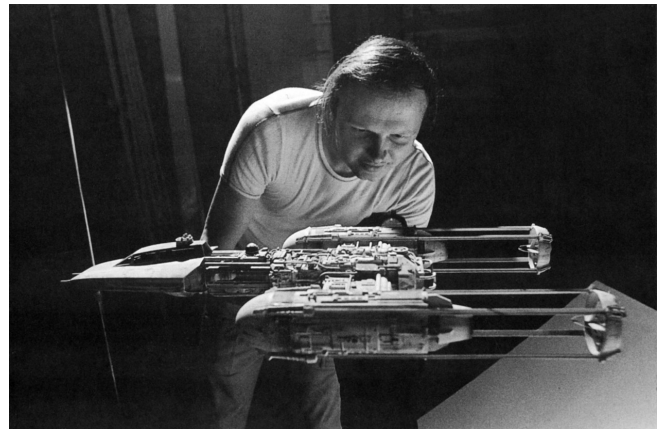
*Equinox* had a brief theatrical run in 1971, with Jack Woods credited as director. Muren bore no resentment. "Jack Harris was totally up-front. He told me the film would be changed, but that it would get finished and out in the theaters. I thought it would be worth it, even though it was not going to be my version. The alternative was to have it sitting on a shelf somewhere – something I could pull down and show my friends once in a while. This way it got seen by a lot of people – and for me, it provided closure to four years of struggle. I could now get on with other things."

While working at Cascade during the mid-seventies, Muren learned that George Lucas was planning to make a big space movie, *Star Wars*, and that visual effects supervisor John Dykstra – who had worked with Douglas Trumbull on *Silent Running* and other projects – was assembling a team to work on it. "I'd always had a negative view of what it would be like to do effects in a Hollywood studio environment, with union restrictions and so on. I was in this small circle of dedicated effects people, all inspired by Ray Harryhausen, who were doing odd jobs and commercials and things while trying to get our own projects going – which was fine, except that we weren't getting our own projects going. The summer I first heard about *Star Wars* there were three big effects movies out – *Island at the Top of the World*, *The Towering Inferno* and *Earthquake* – and I remember watching them and thinking that some of the work was great and some of it was not, but admitting to myself I would love to have worked on any one of them. So I decided to try to get on *Star Wars*."

Muren contacted Dykstra – whom he had met once on a visit to Trumbull's Future General Corporation – and showed him two documentaries on the universe and the solar system that he had made with friend Tom Scherman. As it turned out, Dykstra was more influenced by Muren's background in animation. "He told me about this new motion control technology they were planning to use and said that he thought my stop-motion skill allowed me to think in non-real time, which he felt would be important in that kind of work. And he was right. Complex motion control shots could require as many as twelve axes of movement, all programmed separately in a process that could take hours. Some guys had a terrible time with it."



*Eight-time Oscar winner Dennis Muren ventured into feature filmmaking with *Equinox* – an effects-heavy tale of archaeology students confronting ancient demons – made during his college years with a crew of friends. Muren directed the 16mm production, which was eventually sold, reworked and given a brief theatrical release. Muren animates one of the demonic characters – a stop-motion puppet built by Dave Allen.*



*In his first mainstream Hollywood assignment, Muren joined Industrial Light & Magic – established by George Lucas specifically for *Star Wars* – where he spent about a year working on effects for the landmark space opera. Manning the night shift as second cameraman, Muren prepares a Rebel Y-wing fighter for a motion control shot.*

The Star Wars effects facility – built from scratch in a Van Nuys industrial park and named Industrial Light & Magic – proved an ideal working environment for second cameraman Dennis Muren. “I could light my own shots and program all the moves myself. It was great – very much like the way I’d been used to working and nothing at all like the way movies were being done a few miles away at the major studios.”



*As effects director of photography on The Empire Strikes Back, Muren championed the use of stop-motion animation to articulate the giant war machines on the planet Hoth. On a miniature elevated set, animators Doug Beswick, Jon Berg and Phil Tippett manipulate the lumbering walkers against a painted backdrop.*



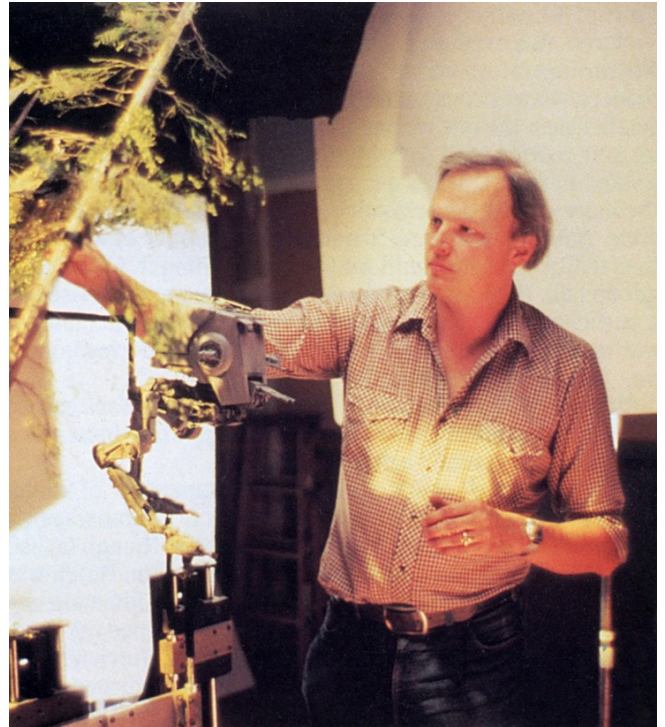
*Advancing to effects supervisor for the medieval fantasy, Dragonslayer, Muren helped pioneer a new technique – go motion – through which puppets were animated via a series of external rods connected to motion control stepper motors.*



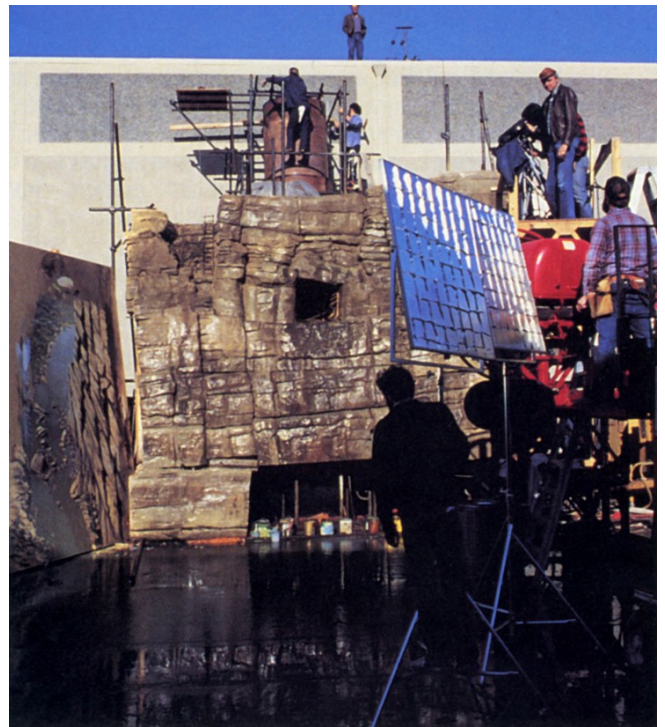
Muren assesses his contribution to *Star Wars* in characteristically modest terms. "I certainly helped them get the movie done. There weren't many people who could learn how to use the equipment. Maybe I helped add a sort of style to the way the spaceships flew around. With motion control, it was very easy to make things look too mechanical. In the attack on the Death Star, I tried to inject a sense of personality in each ship, as if there were a real person inside flying it. I also tried to give an obvious hand-held look to some of the shots – like there was actually a cameraman there who was having trouble following the action. The first time I did that was on a shot trucking down into Luke's ship when he's in the trench. In the screening room, when that comp came on, I remember George and everybody going, 'Wow, look at that!' We did a lot more of it after that."

When *Star Wars* wrapped after more than a year of postproduction, Muren opted not to join his fellow workers in leisurely pursuits. Instead, he headed south to Marina del Rey where effects for *Close Encounters of the Third Kind* were underway at Future General. "It never occurred to me that having two big effects films going on at the same time was anything but a fluke. Sooner or later, I figured things would be back to normal and I'd be doing commercials again. So, with only a three- or four-day break after *Star Wars*, I went down and met with Doug Trumbull – whom I admired tremendously for his work on *2001* – and managed to land a six-month gig shooting the mothership. Doug and Richard Yuricich had already figured out the approach and done the design work; so what I did, pretty much, was just babysit the equipment. Scott Squires was my assistant and Hoyt Yeatman had the night shift; and together we did about twenty very time-consuming shots."

The completion of *Close Encounters* did not bring about a return to commercials for Dennis Muren. *Star Wars* was, by now, an international phenomenon, and the rush was on to repeat its success. A deep-space television series, *Battlestar*



Charged with the land-based effects on *Endor* for *Return of the Jedi*, Muren experimented with innovative camera and lighting techniques. For scenes requiring scout walkers to be composited into live-action plates shot in the woods, miniature trees were used to cast appropriate shadows during bluescreen puppet animation.



On a miniature cliff face and tunnel opening erected in the ILM parking lot, Muren and his crew prepare to shoot the

*Galactica* –summarized in Hollywood shorthand as *Wagon Train* meets *Star Wars* –was already in production for ABC, and its three-hour pilot was to be a visual effects extravaganza. In charge of the effects was John Dykstra, now in business under the name of Apogee, who had retained the former ILM facility and most of his *Star Wars* crew. Muren rejoined the fold.

*finale of an elaborate mine car chase in Indiana Jones and the Temple of Doom.*

“During *Close Encounters*, I had a lot of time to think about motion control and how it ought to be used. I was not a big fan of motion control on *Star Wars*. It was difficult and tedious and we could only get one element a day – and some of those elements were very simple in terms of movement. I thought then, and still do, that we could have gotten the movie done sooner using wires and rods and things like that if we had given the attention to those techniques that we gave to programming the motion control. Thinking about it later, I realized that what really ought to be done was to use that technology and that gear to design shots that couldn’t be done any other way. On *Galactica*, John was very open to change; so it was that project, really, that gave me a chance to show what I could do in designing shots. I was only on the show for about three months; but during that period I did ten or twelve shots that were really complex – shots with moves and perspective changes that couldn’t have been done any other way but with motion control. Being allowed the freedom to experiment enabled me to show that there was a lot more we could do with that technology than anyone had really attempted before.”

About the time *Galactica* was winding down, George Lucas announced that he was going to do a second installment in the *Star Wars* saga, and that Industrial Light & Magic would be re-instituted as part of his new media empire in Northern California. Members of the original *Star Wars* team had to decide whether to stay in Southern California with Dykstra or head north to the rural expanses of Marin County. It was not a difficult choice for Muren. “I liked everyone at Apogee and they wanted me to stay, but I never felt like I quite fit in there. They had formed a company partnership with ten people and never asked me to join – so I thought, well, okay. I wasn’t crazy about moving to Northern California; but the idea of doing another *Star Wars* film was really appealing, so I came up to see what George was doing. He showed me all the artwork and everything – and it was just too good. I had to do it.”

Elevated to effects director of photography, Muren spent the preproduction phase working on scheduling and effects approaches for the show while the facility was being built and equipped under the direction of effects supervisor Richard Edlund, who had been first cameraman on *Star Wars*. “One of the things I contributed to *The Empire Strikes Back* was the idea of doing the walker sequences with stop-motion instead of motion control. The original plan was to build motorized puppets and all this hardware – and I thought that was the wrong way to go. On *Star Wars* –also *Galactica* –I had seen a lot of time and money invested in developing technology that never really worked. The mood of the moment was that you built things to solve problems – but to me, here was a problem that didn’t need to be solved. There was already a perfectly good way to do it – with stop-motion.”

Having won his point, Muren enlisted Phil Tippett and Jon Berg – two old friends from Cascade who, at his behest, had been brought onto *Star Wars* to animate the holographic chess game. Together with effects designer Joe Johnston, the trio worked out the logistics of the climactic battle between

rebel forces and the giant walking war machines, then set to work on it. “We used stop-motion puppets and miniature sets with trapdoors and painted backdrops – all things we had learned and done before. Stop-motion was the perfect approach, especially since the walkers were supposed to move mechanically anyway. We also used some larger-scale models for high-speed shots of the walkers blowing up and collapsing.”

Muren also expended considerable effort on scenes of the Millennium Falcon being chased through an asteroid belt. “The model shop was constructing a new Falcon for the sequence – smaller than the one we had used on the first film – and while we were waiting for it, I shot probably half of the sequence with a stand-in model, just to get a jump on it and work out some of the moves. From the beginning, it was a race to get that show done. Not only was there a tremendous amount of work, but the facility was being built while we were doing it. All our gear got up late. There was camera equipment we were promised by a particular date, and it would be ready four months later. It was really nerve-wracking – the hardest show I’d ever worked on – way beyond *Star Wars*.”

Muren’s efforts on behalf of *The Empire Strikes Back* earned him his first Academy Award. “I actually kept it in a drawer for a year because I couldn’t believe I’d won it.”

Muren remained at ILM, graduating to supervisor of miniature and optical effects for his next project, *Dragonslayer*, a medieval fantasy directed by Matthew Robbins. Though he had long been a proponent of stop-motion animation, Muren was nonetheless aware that many filmgoers – and filmmakers – found aspects of the technique unconvincing. Since the dragon in *Dragonslayer* was to be a major character, Muren felt that an alternate approach would be needed to win audiences over. “Stop-motion has its advocates – I love it myself – but the moviegoing public, for the most part, doesn’t buy it. A lot of the guys I started out with in the business love stop-motion – they love the process. They love pouring the foam and making the armature and creating every little nuance of movement frame by frame. But I’ve never had that feeling about it – mainly, I suppose, because I’m not an artist, in the sense that I can’t draw and I can’t sculpt, and I never thought of myself as much of an animator. For me, the end result is all that matters – not the process – and I’m willing to consider anything that will enhance the end result.”

Though others were suggesting that stop-motion be merged with motion control via a motorized armature that could create convincing motion blur on each frame, Muren at first proposed that the dragon be done using a sophisticated rod puppet. “We had tried using motion control to help the stop-motion taun-taun in *Empire* – to give it motion blurs since it was going to be running – and it did sort of help. But it took such a long time to do. With a rod puppet, I thought we could do it quickly and with very fluid movement. One of the guys here took that idea a step further and came up with a rod puppet attached to programmable motors. Compared to other systems, it recorded very quickly and at a relatively low cost, so that was the direction we decided to go. Phil Tippett would first program the major moves into the computer – for repeatability and motion blur – then he would hand-animate things like facial features and claws. I’m not sure it was any faster – I remember one shot taking us two weeks to program – but the work looked really great, a big improvement over stop-motion.”

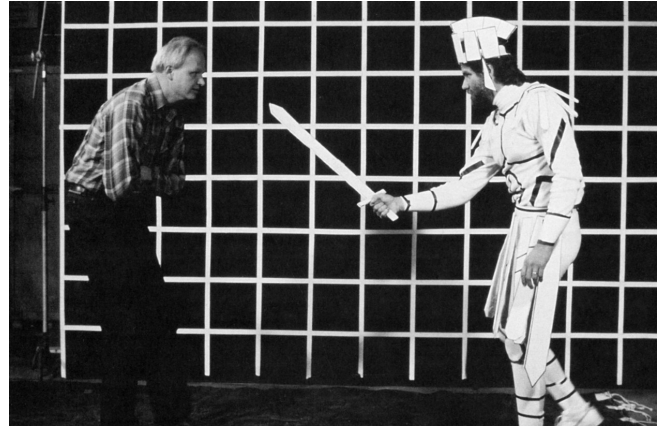
Intrigued, Muren decided to analyze exactly what it was that made the shots so believable. He suspected there was more to it than just motion blur. “We took one of the programs Phil had done and used it to shoot the model, first with a 180-degree shutter on the camera, so it had all the blurs, and then with no shutter and no blurs. It looked almost the same. That was the tip-off for us that the problem with stop-motion was not that there’s no blur – although that’s some of it. Mainly, the animator is just not hitting the mark. No matter how good he is, each increment is just a little bit off – and that’s what creates the chatter that bothers people so much.”

Muren earned an Oscar nomination for *Dragonslayer* –his second in a row – losing out in the voting to *Raiders of the Lost Ark*, another ILM project completed the same year. He did, however, win a technical achievement award, shared with Stuart Ziff, for the development of the motion control puppet mover. The technique born of the technology was given a tongue-in-cheek appellation ‘go-motion’ – which promptly stuck.

Go-motion would be featured again in the signature flying bike sequence from *E.T.*, Steven Spielberg’s phenomenon that was to be Muren’s next assignment as visual effects supervisor. “*E.T.* was a low-budget film. Everyone was looking at *Poltergeist* – which Steven was producing, but not directing – and thinking that would be the bigger movie.

*Poltergeist* was also being done here at the time, by Richard Edlund, and that had pretty much taken over the whole place. Ken Ralston was doing the second *Star Trek* movie at the same time. So we had just a corner of the shop, literally, to do Steven’s little alien movie.”

Though all three shows were struggling for space and resources, compromising on quality was never a consideration. “Aesthetics played a lot bigger role than usual in *E.T.* Allen Daviau shot the film – and it was beautifully done. I wanted to get some of that same aesthetic into the effects, so we made a great looking setting sun and great looking bikes going in front of the moon. It was something I hadn’t been able to do much before. Aesthetics were important, of course – I knew that – but somehow they never seemed to play much of a role in effects. But with *E.T.*, the way Allen had shot the film cried out for effects that were very rich and self-conscious, with everything lined up



Working with the Pixar Computer Animation Group – established by George Lucas as an entity separate from ILM – Muren oversaw groundbreaking work in digitally engineered effects for *Young Sherlock Holmes*. To realize a fully computer generated stained glass knight for a hallucination sequence, Muren provided digital artists with reference footage by photographing costumed model shop crew member Jeff Mann against a background grid.



Taking a brief detour into special venue filmmaking, Muren directed a four-minute film for Disneyland’s Star Tours attraction, which married sophisticated flight simulator technology with motion picture visuals. Model shop supervisor Steve Gawley and Muren attend to last-minute detailing of a shuttle station set for the film, designed as an uninterrupted journey with no apparent cuts.



perfectly, and with just the right lens flare and just the right color. Ken Smith did incredible comps in four-perf that held up completely, and the whole experience was quite wonderful.” E.T. swept everything off the screen that year; and for his contribution to it, Muren was rewarded with his second Academy Award.

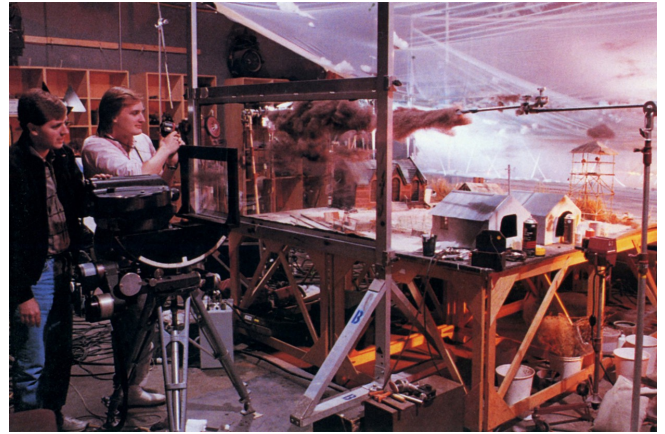
For the next year or more, ILM turned away all outside projects, marshaling its forces for the third installment in the *Star Wars* saga, *Return of the Jedi*. All three of the facility’s first-string effects supervisors – Muren, Edlund and Ralston – were assigned to the show, each taking specific sequences that seemed best suited to their individual styles and strengths. Muren was in charge of the land-based effects on Endor, including a dynamic speeder-bike chase through the forests and a pitched battle between primitively armed ewoks and high-tech Imperial scout walkers. “We used stop-motion again for the walker scenes, but what we tried to do was get away from the locked-off shots that are typical of that technique. We did quite a few shots – full composites with people and live backgrounds – that had significant camera movement. Match-moving the elements was tricky and time consuming, but you really got the sense that these machines were in the environment. My biggest contribution to *Jedi*, I think, was coming up with an approach for the bike chase. Joe Johnston and I spent about three days working out the whole sequence in animatic form – using a little bike mockup and cardboard tubes for trees and the first tiny digital video camera I had ever seen, that you could actually hold in one hand. Once we had that animatic, we knew exactly what we needed in terms of shots – and there were about a hundred of them. Rather than build a miniature forest, we put a Vistavision camera on a Steadicam rig and then went out in the redwood forests around Eureka and had Garrett Brown walk through the woods – with his Steadicam held at just the right level off the ground – shooting at one frame per second. The resulting plate material had a real documentary-style look that was just what we wanted.”



Muren proposed using large-scale miniatures and mostly in-camera effects for *Innerspace*, a voyage through the inside of a human body. With key grip Pat Fitzsimmons and effects cameraman Don Dow, Muren surveys a full-scale mockup of the submersible pod featured in the film.



Muren considers *Return of the Jedi* a turning point for ILM in terms of company management. "We all knew that *Jedi* was going to be a huge film – bigger than anything we had done before – and I was as insistent as I could be that we needed a strong production team in place to allocate resources. What had happened on *E.T.* was still fresh in my mind; and I knew that if we all had to battle for resources on a film as big as *Jedi*, we'd never get it finished. Rose Duignan was brought in at that time, and she very effectively managed all the resources of the place. It made a tremendous difference – we all had what we needed when we needed it, for the most part – and the company really started functioning like a business." Muren earned his third Oscar for *Return of the Jedi*.



Among the effects contributed by Muren and ILM for *Empire of the Sun* were several shots of an Allied air raid on a distant city as seen from a World War II prisoner of war camp. Matte painter Michael Pangrazio and matte photographer Craig Barron prepare for the shot, which used a painted background and miniature foreground in combination with various lighting effects.

*Indiana Jones and the Temple of Doom* – his next project – had effects on a much smaller scale, but was not without its challenges. An elaborate mine car chase, done with miniatures, and a climactic sequence centered around a lava pit were among the highlights. "It was tough trying to figure out how to get the lava to work. After a lot of testing, we wound up using floating bits of cork and plastic on swirling glycerin that we lit from below to look like it was glowing." Muren forged a strong relationship with Steven Spielberg during the show – one that would afford him an abundance of opportunities in the years to come. "We had to go to England to shoot plates for it, and I spent a lot of time on the set. It was great working with Steven. He was very demanding and insistent upon getting interesting and unusual angles – but his ideas were good and his input helped us a lot."

Two years earlier, Muren had been surprised when *E.T.* won the effects Oscar, beating out *Blade Runner* and *Poltergeist*.

"I thought *Blade Runner* should have gotten it." He would be surprised again on *Indiana Jones and the Temple of Doom*. Though pitted against *Ghostbusters* and *2010* – two enormous effects productions overseen by Richard Edlund, who had left ILM to form Boss Film Corporation – *Temple of Doom* would earn Muren his third consecutive Academy Award. "Being up against two Richard Edlund movies, I figured one of them – probably *Ghostbusters* – was going to win. Assuming the effects were equal on both shows, maybe people found *Temple of Doom* more imaginative and unique. Who knows?"

Muren received a sixth consecutive nomination – but no Oscar this time – for his next project, *Young Sherlock Holmes*, an Amblin Production directed by Barry Levinson. "The film had three major effects sequences. I thought it would be fun to try something different for each one." Go-motion and sophisticated match-moves were employed for a sequence in which a professor is attacked by a pair of bird-size harpies, and rod puppets were utilized for a scene in which young Watson hallucinates about ambulatory pastries. But the true groundbreaking work was reserved for a sequence in which an elderly clergyman is menaced by a stained-glass knight come to life. Looking for an approach

other than stop-motion or rod puppetry, Muren decided to feel out the Pixar group, a small research and development unit established by George Lucas a few years earlier to explore the potential for digital applications in mainstream filmmaking.

“My interest in computer graphics began around the time we were finishing up on *The Empire Strikes Back*. Somebody sent over a test film that was done by Triple-I [Information International, Inc.] of five X-wings flying around. It was all CG. It had its flaws and there was no motion blur, but the potential was there. I could never have programmed a motion control shot like the one they had done. They had enemy spy ships flying around, one of which did a loop-de-loop around the frame and then flew under the camera. I thought it was great – and so when the Pixar group started up, I kept an eye on what they were doing, looking for opportunities to work with them.” Though Pixar had done the Genesis effect for *Star Trek II* – a stand-alone sequence in video resolution – Muren’s attempts to involve them in further effects production met resistance. “I could see that they were getting closer and closer to something that was usable in the filmmaking process, but the feeling there was that they weren’t ready yet. Their tools had not been perfected. I told them the same was true around here – the tools are never ready. You just go with what you’ve got. I thought the stained glass man in *Young Sherlock* was a perfect opportunity for them to show what they could do. Once they agreed to it, we decided to go for a stained glass man that couldn’t be done any other way. My wife suggested the approach – to make him like a glass mobile, with none of the pieces connected to each other. The work was terrific, a real tribute to the Pixar guys – John Lasseter and Bill Reeves especially. I only wish the sequence could have been longer – but it took six months just to do that thirty seconds’ worth of work.”

Although features had always been his principal interest, Muren enjoyed the change of pace provided by his next project, a four-minute point-of-view film he directed, based on the *Star Wars* mythos, for the ‘Star Tours’ simulator ride attraction at Disneyland. Then he transitioned into *Innerspace*, for director Joe Dante, which afforded him the opportunity to revisit some of the low-tech approaches he had relished as a youngster and entry-level effects practitioner. The story of a miniaturization experiment run amuck, *Innerspace* entailed a journey into the human body of the sort that had not been attempted since *Fantastic Voyage* twenty years earlier. “The idea with *Innerspace* was to come up with environments representing the human body that were organic and convincing, without being totally disgusting. My suggestion was to use large-scale miniatures and do a lot of the shots in-camera, staying away from opticals as much as possible. Harley Jessup, our art director, came up with most of the designs – which had a kind of yucky feeling to them – and then we worked with the model shop guys on materials to make them look real. My original idea was to shoot everything as though it were being photographed through microscopic lenses with very limited depth of field – like there was actually a tiny little camera inside the guy – but I soon realized that would never work because we had an actor, Dennis Quaid, who was supposed to be shrunk down to the size of all these other things, and we couldn’t very well photograph him that way. It would have been a little hard to watch. So I had to fall back on a more traditional look for the film.”

Muren picked up his fifth Oscar for *Innerspace*, then segued into *Empire of the Sun*, the story of a young English boy, in occupied China, forced to fend for himself when separated from his parents during World War II. Though hardly an effects showcase, no Steven Spielberg picture is ever

completely without effects, so Dennis Muren and ILM were enlisted to produce a few bluescreen composites with backgrounds that combined miniatures, paintings and lighting effects to suggest an air raid by Allied warplanes on a distant city. Computer graphics were employed for an accompanying scene of aircraft flying overhead. "It was not an altogether successful attempt. We tried doing about fifty planes flying over, but the resolution of our output device was not sufficient to keep them from looking fuzzy. In *Young Sherlock Holmes*, the scene with the stained glass man was dark, so we were able to get away with it. But here it was broad daylight, and we had these planes against a bright sky. It took us forever to do it, and they still weren't quite sharp."

*Willow*, a lavish fantasy produced by Lucasfilm and directed by Ron Howard, was next on Muren's agenda. Like *Return of the Jedi* – the last production of its magnitude to transit ILM – *Willow* required the services of multiple effects supervisors. "Mike McAlister, Phil Tippett and I split up the work. That film had several highlights for me. There were a lot of scenes with little brownie characters running around, and Mike and I worked out a technique, using pin-blocking, so that we could have very fluid camera moves on the brownies rather than the usual locked-off shots that were standard with tiny people in movies. But what everyone seems to remember most was the morphing." For a scene in which a sorceress is restored to human form – transitioning from possum to goat to ostrich to turtle to tiger on the way – a series of rod puppet animals was created and then image-processed by the ILM computer graphics department to create the impression of a smooth, uninterrupted transformation. The illusion – unlike anything ever seen in a feature film – caused an instant sensation, and promptly became the 'effect du jour' in countless film, television and commercial applications.

"By the time *Willow* came along, Pixar was now a separate company, and we had a new computer graphics department as part of ILM. It was John Knoll, I recall, who mentioned to me that he had seen some footage someone had done where two images were merged together on a computer. I thought there might be something in that idea, so I brainstormed it with our CG guys. Eventually Doug Smythe wrote a program to do the morphing – and the rest, as they say, is history. As with our other early attempts to use CG, we were limited by the capability of our output scanner. Probably one out of every ten times, if we were lucky, it worked – maybe one out of twenty. It would take a day to do each shot – then break down and be out of commission for a week or more. It was pretty frustrating."

After *Willow*, Muren took on *Ghostbusters II* for director Ivan Reitman, another big project. But it was a job that came in about the same time – much smaller in many respects – that really captivated him. "I was frankly getting a bit bored after *Willow*. Everything seemed like more of the same – the same techniques, the same images. I kept hoping for something different. Then Jim Cameron came to us looking for someone to do the pseudopod for *The Abyss*. I thought: 'Now here's something different! Here's a sequence you don't want to use the old technology on.'" Uncertain that it could even be done, Muren and the ILM CG team focused their resources on creating a shape-shifting water tentacle solely through digital means, succeeding to a degree that sent a definite wake-up call to Hollywood regarding the cinematic potential of computer graphics technology. "It started with a wonderful idea – which is always the most important part – but I was as surprised as everyone at how startling the images were. Not only had we done the pseudopod with CG, but we had done it pretty much on budget and on time – which meant that CG was now a real tool we could count on.

That realization affected me so profoundly that, after *The Abyss*, I decided to take a year off and learn everything I could about computers – because I really didn't know that much."

Muren bought himself a Macintosh and began tinkering at home. "John Knoll showed me an early version of PhotoShop, and said: 'You know, you should really look at this. You can do compositing and painting with it.' ILM already had compositing software and a paint program – the problem was, it was very difficult to use. I started playing around with PhotoShop and tried to composite with it – and it was amazing! The results were better than an optical comp. Not only that, it was incredibly easy. So I began to wonder if we could get digital compositing to the point where anybody could do it, where you didn't need to be a computer scientist to figure it out. I remember this period vividly, staying up until 3 AM, too excited by the potential to sleep."

Enraptured by the technology, Muren shifted his focus to what he considered to be the weakest links in the digital process – input and output. "For us to be able to actually use this technology in production, we had to be able to digitize shots, comp them or manipulate them or do whatever we wanted, then get them back to film again. I thought that with PhotoShop and a Mac, we had at least a middle part that would actually work for compositing. That left the input and output. We had a film recorder that Kodak and ILM had been jointly developing, and I gave the people working on it some specifications for the lowest resolution we could possibly get away with. Then, for the output, I began looking at existing film recorders, and found one made by Management Graphics that had good enough quality but, as far as I know, had never been used to film out a photograph. It was mostly for graphics. Pretty soon, we had a workable system for digital compositing – we had the input, the middle and the output. We set up this little Mac squad – mainly it was Stuart Robertson – and we began doing a few shots for shows like *The Rocketeer* and *Memoirs of an Invisible Man*. They were great – the stuff looked wonderful."

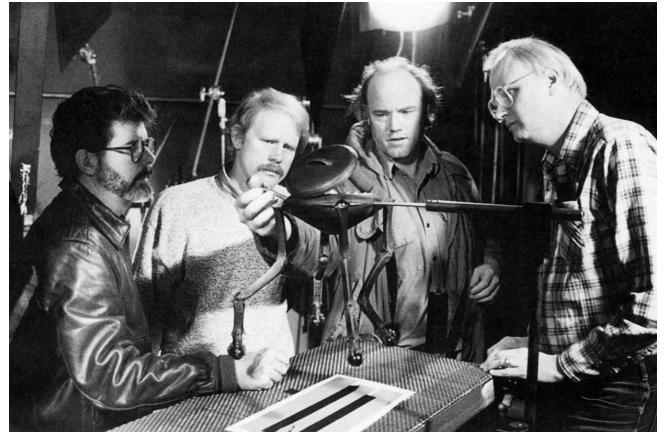
Getting ILM to embrace digital compositing was not an overnight affair. "We ran into opposition from all different levels. Management was concerned about the cost. Employees worried they were going to be out of work. Even at a place as advanced as ILM, tradition comes into play and you don't want to rock the boat too quickly. It was a slow process. I remember taking a real problem shot from the third *Indiana Jones* movie – a bluescreen shot from the airplane sequence that just never came out right – and redoing it with Macintoshes. We screened it in dailies and it was amazing – it just popped with reality. At least that's what I was seeing. Next to me was someone saying, 'It doesn't look that different to me.' And I'm thinking, 'What is he seeing?' Well, what he was seeing was his job going out the window. But, in fact, what we did, eventually, was bring everyone into it. Today, some of the guys who fought it the most are our very best digital compers." Oddly enough, it was not only the optical veterans who fought the advance. Much of the CG team resisted as well. "They didn't want to do 2-D work. 'We don't do comping,' they said. They just wanted to do 3-D things. Eventually they came around."

Once the company endorsed the concept, its higher horsepower computing engines were brought into the digital compositing loop – just in time for the film that would put digital technology squarely on the map. "When Jim Cameron brought *Terminator 2* to us, I thought, 'This is the one.' Not only did it have complicated CG work and terrific ideas, but with digital compositing, there would be no matte lines and no image degradation when the shots came together. We were still at the early stages, however, so I agreed originally that we would do ten shots digitally and all the rest

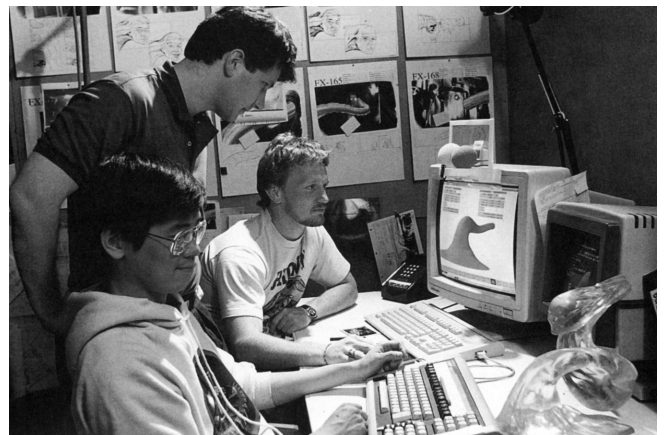
photochemically. Then, as we got into it, 1 pushed for more. 'Can we do twenty?' 'Okay, we'll give you twenty.' By the time we finished, we had done the whole show digitally. The work really blew people away – including us. But when it was over, what surprised me the most was that it took a year before L.A. really caught on to it. I think they just didn't see it. The CG imagery was so strong that nobody noticed the digital compositing – and that's where the big breakthroughs were for everybody. With a \$12,000 input device and a \$30,000 output device, and some Macintoshes in the middle running PhotoShop, we had come up with a way of eliminating bad comps from movies."

As he had with his first Cameron project, *The Abyss*, Muren earned another Oscar for *Terminator 2* – his seventh. His eighth would come for *Jurassic Park* – a quantum leap in digital technology that started out being a conventional puppet animation project. "About the time we were finishing T2, I had a couple of meetings with Steven Spielberg and Kathy Kennedy about *Jurassic Park*. At that point it was a huge, huge project – practically impossible – and we were looking at doing it with stop-motion and go-motion. I was intrigued with the idea of doing some of it CG, but I knew the hangup was going to be the skin. I figured we could get the animation down, but the skin would be the killer – I'd never seen CG skin that looked real. But then *Jurassic* went into rewrite and Steven did *Hook*. During that period, I spearheaded a CG test for *Death Becomes Her* for the scene where Meryl Streep has her head on backwards – and the skin on that looked pretty good. Maybe we were ready to try something bigger."

When *Jurassic Park* resurfaced, the effects had been pared down to a more manageable number. Though the plan was still to use go-motion for most of the shots, Muren and others in the CG department tried a couple of tests to determine if computer generated dinosaurs might suffice for distant shots. Spielberg was so impressed with the kinetic nature of the rough tests that he made a decision to forego puppet work altogether and commit fully to CG dinosaurs. Muren and ILM had no choice but to work out the thorny issues still remaining. "I see almost everything we do as an opportunity. You can either play it safe and stay put – or you can go someplace new. I always look at shows as opportunities to do something different. I feel that's what I'm being paid



Fantasy effects in *Willow* were divided among supervisors Muren, Micheal McAlister and Phil Tippett. Tippett – with Muren, executive producer George Lucas and director Ron Howard – demonstrates puppet articulation for a stop-motion sequence in which a brazier, zapped by a witch's wand, magically springs to life.



In *The Abyss*, computer generated images of an undulating water tentacle – sent by nonterrestrials to probe an underwater oil drilling habitat – would bring a new awareness of digital technology to mainstream moviemaking. Working under Muren, animator Lincoln Hu, computer graphics designer John Knoll and software engineer Scott Anderson collaborate on the CG creation, which convincingly simulated the reflective and refractive properties of seawater.



to do. The client wants it; the audience wants it. One of the things I like most about the new technology is that things can really look different now. Someday – five or ten years from now, or maybe less – we’ll probably hit a wall. People will be able to accept absolutely anything on film, and it won’t seem as wonderful to them anymore. What happened with morphing will happen to digital effects across the board – they’ll become overexposed. Once people figure out the trick, it’s no longer much fun for them.”



*Breakthroughs in digital compositing and character animation were achieved in Terminator 2. Among the computer generated scenes was one in which a liquid metal cyborg transmutes from an amorphous blob to a precisely replicated human form in shining chrome.*

After the photorealistic terror of dinosaurs on the rampage, Muren transitioned into kinder, gentler imagery with *Casper*, an Amblin production, directed by Brad Silberling, that called for forty-two minutes of CG character animation as compared to *Jurassic Park*'s six and a half. "Doing ghost characters was a really interesting challenge. Starting with a blank slate, we had to figure out what the performance should be, and then do full character animation that the audience could read and understand. We found it incredibly difficult – especially since the film was shot just like a live-action show. We had to put characters in shots that were a minute or more long, and sustain the performance from first frame to last. And even though they were ghosts, they couldn't look animated because they were in scenes with real actors and would be judged unconsciously the way a human performance is judged."

Since the dawn of computer animation, the creation of a photorealistic human character has been the Holy Grail of digital artists. Many outsiders, unversed in the technicalities, have speculated on the likelihood of CG characters one day replacing human performers. Based on his experience with *Casper* – the most human CG work to date – Muren is not about to suggest that actors surrender their SAG cards. "There are so many subliminal clues as to what reality is that it's almost impossible to conceive of someone nailing all of them to the point where a CG human could be in a scene with live actors and not look fake. I think the people who are saying they're ready to do it haven't got a clue as to how far away they are. I don't personally, at the moment, have interest in trying it. I think if you want Humphrey Bogart in your movie, you should go find a terrific actor, give him six months of training, and you'll have something far better than could be done with computer graphics, for a fraction of the cost. But I don't expect the obsession will go away – it's almost a religious thing for computer guys. Everyone wants it."



Initial plans to use puppet animation in *Jurassic Park* were abandoned when tests by Muren and his digital team proved that dinosaurs could be rendered and animated with full conviction in the computer. The results represented a quantum leap in technology that would revolutionize the effects industry. With computer graphics artist Steve Rosenbaum and lead CG supervisor Stefen Fangmeier, Muren reviews animation for a velociraptor shot.



*With more than forty-seven minutes of screen time – seven times that of Jurassic Park’s dinosaurs – the sophisticated quasi-human ghosts of Casper further advanced the art of digital character animation.*

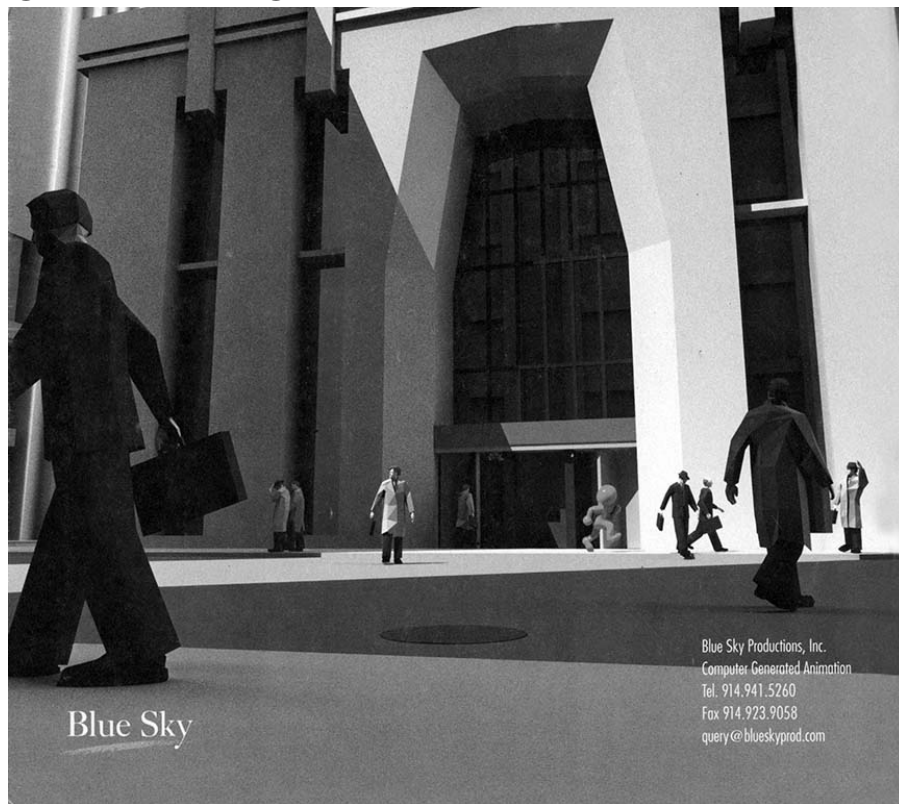
Since wrapping *Casper*, Muren has been overseeing the completion of some sixty new and revised visual effects shots for the *Star Wars* special edition which will be released theatrically in 1997. “George wanted to fix up some of the shots and add a few that he wasn’t able to do back when the film was first made – and I had a couple of dozen I was never happy with that he let me include. Half of them no one will notice. The movement on the spaceships will be smoother and glitches will be gone on some of the motion in the battles. Other shots are new and designed to create more of a sense of life and environment than we saw before.”

Next on Muren’s agenda is *The Lost World*, Steven Spielberg’s much anticipated sequel to *Jurassic Park*. Where to go from the original? “I think there still is room for technological improvement. I saw the first film again, just a few weeks ago, and I was struck by how well it holds up, even after two years. But I can see the need for improvement on skin and bumps and muscles and things. I don’t think you can look back on *Jurassic* and say, ‘Well, that’s all there is to CG.’ We may never get to that point. But I do think the biggest change has already come. I don’t see anything on the horizon to equal what has happened in the last few years.”

Although he has been at its forefront for more than two decades, the effects revolution – driven now by the digital juggernaut – is not entirely a welcome development for Muren. “To me, the imagery is not as special as it was – perhaps because there’s so much of it now. When I was growing up, effects films were rare – in his whole career, Ray Harryhausen did maybe a dozen – so when you saw a particularly good one, you cherished it and preserved it in your memory. I used to spend hours trying to remember the images I saw. A Speedy Alka-Seltzer commercial on TV used to be an event – now half the commercials you see have CG in them. Effects are everywhere. You can rent or own the movies; you can do freeze-frames and study every minute detail; you can do printouts. And you know what? It’s just not as interesting anymore. I look at most of the work being done now, and I think aesthetically it’s very weak, a lot of it. Almost anyone can do effects now; and so we have people out there happily turning out images, whether they have any talent or not. Effects are so commonplace that if I were growing up today, I don’t know that the spark would be there to attract me. But lots of young people are attracted – some of whom consider us old-timers practically obsolete. We have people now at ILM who look at the work we did on *Star Wars* like people of my generation used to look at silent movies. Some of them are pretty scornful about it. ‘What did you guys think you were doing? We’re really doing it now.’ I know that’s just youth talking – and youth is important for change to happen – but it’s oddly disturbing to have your life’s work dismissed and thrown out. But it will happen to them, too. Someday their work will also be thrown out – and it will be up to historians to look back on it and recognize it for what it was.”

Over the years, Muren has seen most of his top contemporaries leave Industrial Light & Magic in search of greener pastures. After the first *Star Wars*, John Dykstra parted ways with the company to start Apogee. After the third one, Richard Edlund left to form Boss Film Studios. Ken Ralston departed only recently to head Sony Pictures Imageworks and pursue a directing career. Others have come and gone, as well – but Dennis Muren remains, holding true to a course he set for himself more than twenty years ago. “There was a time – I think before *The Abyss* – that I was getting a bit bored with effects and restless. And I considered rather seriously the idea of directing a

picture. But then effects rekindled my interest, and I've been very happy exploring digital technology as a way of creating different kinds of images. As for going to another effects facility, I have been approached from time to time – sometimes very persistently – but I've never been in this business for the money, so the offers have never been that tempting. I've always felt that I had the best chance of doing the best work right here at ILM.”



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